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A RING NEBULA (DARK) IN CYGNUS.

By D. W. MOREHOUSE.

Everyone who has had the opportunity to make long exposures on the galaxy is familiar with certain remarkable areas. The Orion region is probably the most attractive and fascinating, especially for small scale photography. Scutum and Sagittarius contain many interesting nebulae of both the bright and dark type. The constellation of Cygnus comprises a region which is most remarkable in the variety and nature of these nebulous objects. Of course the central figure is the North America nebula. A recently published small scale photograph in "The Universe of Stars," Harvard Observatory, shows the extent and relation of these interesting areas.

In 1910 I made a long exposure of this region on a Sigma Lumiere plate. The exposure was started with the thought of sensitizing the plate by exposing it to the faintly illuminated evening sky. On developing the plate a number of curious spots appeared. Anyone who has worked with Lumiere plates knows this is characteristic of the brand. I was attracted by the prominence of a distinct small ring in the upper region of the North America nebula, a little to the north of the "St. Lawrence River" region. It had the appearance of a ring formed by the absence of stars. A second photograph at that time verified the existence of the structure, although it was not so conspicuous. During the summer of 1926 on two remarkably favorable nights an exposure was made by Mehlin and Zug, covering a period of nine hours and forty-five minutes. This ring stood out with tantalizing clearness. A careful examination of the negative convinced me that the structure is a ring of black nebula. One can see the stars through the ring. Recognizing how impossible the statement appears, it nevertheless seems as if a portion of the light from single stars had been partially cut off by the edge of the ring. At the bottom of the ring there are two stars which appear to lie between the observer and the black nebula. The reader must recognize that I am using the word "appear." I have been referring to this object for a number of years as "The Birds' Nest" in the "Hudson Bay" region.

The nebula forcibly reminds one of the Ring Nebula in Lyra except that it is much larger. It is perfectly feasible that this marking should be caused by a ring of absorbing material comparable to the wisp of black nebulae in the lower part of the Cygnus region which has fre-

quently been referred to as the complement of the bright nebula about Kappa Cygni. There seems to be a quantity of this black material scattered throughout this portion of the Milky Way. The difficulty of explaining a ring formation ought not to interfere greatly with our accepting the reality of this interesting object. Undoubtedly the question of its nature will be settled by proper exposures with large scale.

I quote the following paragraph from some correspondence with Dr. Fath, Director of the Goodsell Observatory: "I have been studying that ring in the North America nebula on various photographs that we have of the region, but must confess that I have been unable to reach any conclusion other than that it exists. It is certainly a very peculiar structure in that it is so nearly circular. I wonder if it could be a dark ring nebula." I am not assuming that this object is not well known, but so far as I know, the possibility that it is a ring of dark nebula has not been suggested.

There are other indications of irregular rings or wisps of dark nebulae which seem to be projected against the starry background. At the upper part of the dark lane bordering the west coast of the "United States" is another structure comparable to the Birds' Nest, but not so conspicuous.

CASSIOPEIA.

The Northern Cross is tilted to the Pole;
Beside the Milky Way the Crown is dim,
But there beyond the promise of these two
Humanity's eternal questioning
Is traced in a gigantic group of stars.
Whence came I to the earth? and Who am I?
And Whither am I bound? and Why? man pleads.
But he has not been answered all these years;
Only each night majestically are writ,
In silent, fiery figures on the sky,
These three: the cross, the question, and the crown.

GRACE HUNTER.

820½ Main Street, Cedar Falls, Iowa.

REPORT ON MARS, NO. 38.

By WILLIAM H. PICKERING.

The Double Canals, Imagined and Real.
The Narrow Doubles.

In my last Report I gave what seemed to me to be the best explanation available of the three kinds of canals visible upon Mars. In the present one I shall deal with the question of the reality of the double ones. These canals were divided by Lowell into two classes, the wide and the narrow. The division was placed by him at a width of 5°.5 measured on the planet, or about 200 miles. I should place it at 10°, or 370. It should be noted with regard to this subject that there are two distinct questions involved, which should by no means be confused. The first is as to the reality of the appearance, and the second is as to its explanation.

With regard to the first there can hardly be any doubt. The appearance has been seen by a score of practiced Martian observers, among whom may be named Schiaparelli, Perrotin, Terby, Molesworth, Lowell, Douglass, the two Sliphers, Antoniadi, Jarry-Desloges, the two Fourniers, Maggini, Hamilton, Wilson, and the writer, and all of their descriptions of the phenomenon coincide. The observation is a difficult one, and can only be seen under very favorable circumstances, and even then only at brief intervals, "by flashes of revelation" (Lowell Bulletin **15**, 97). With regard to the second question on the other hand, the explanation of the phenomenon, there is a marked difference of opinion among the observers, and they, by the way, are the only persons who have any right to express any independent opinion on the subject at all.

All the earlier observers, and all those who have been connected with the Lowell Observatory, with the exception of Professor Douglass, believed or believe that the phenomenon is real, and due to two actual Martian canals, parallel, and located 75 to 200 miles apart. See an interesting discussion in the Lowell Bulletin, above mentioned. The writer has always felt hitherto that with our present means of observation it was impossible to settle the question, when the separation of the canals amounted to less than 0".5. Few canals have exceeded this figure. Two alternative explanations were proposed by him, one that the appearance was due to a contrast effect (Report No. **5**) the other that it was due to an occasional brief regular vibration due to our atmospheric waves (Report No. **16**).

The duplication of the canals, as stated by Schiaparelli (Memoria **6**, 106) and confirmed by Lowell, is most marked at three of our months before the summer solstice of the northern hemisphere of the planet, and again five months after it. These dates correspond to ⊙ 50° and

165°, the corresponding Martian Dates being April 50 and September 10. The recent apparitions that were most favorable from the standpoint of duplications were those of 1916 and 1922, whose oppositions occurred on February 10 and June 10. Those apparitions occurring in June are much the more favorable of the two, since the planet then appears to be nearly fifty per cent larger than it does in February. This difference is of exceptional importance in studying a phenomenon of this sort. On the other hand the planet is much farther south in June.

In Table I is given a description of all the narrow doubles that I have observed. Their number is rather small, because I have always held that any features which were so difficult that I could not hold them in steady vision were too uncertain to make it worth while to devote much time to them. That is to say I felt that my time could be better spent in a study of those features that I could see more clearly. I therefore

TABLE I.

NARROW DOUBLE CANALS OBSERVED IN JAMAICA.

No.	Date	☉ °	M. D.	Diam. ″	Canal	Arc ″	Deg. °	Miles
1	1914 Feb. 24	40	Apr. 28	10.3	Thoth	0.27	2.9	110
2	1916 Mar. 3	62	May 21	12.7	Protonilus	....	...	...
3	1916 Mar. 5	63	May 23	12.5	Gehon	.50	4.5	170
4	1916 Mar. 5	63	May 23	12.5	Deuteronilus	.25	2.2	85
5	1916 Apr. 7	78	May 56	9.5	Gehon	.26	2.9	110
6	1916 Apr. 7	78	May 56	9.5	Deuteronilus	.20	2.3	90
7	1922 July 8	187	Sept. 49	19.3	Gehon	1.12	6.5	245

merely recorded what doubles I saw or suspected, but never hunted for them. Neither have I ever entered any of these narrow doubles upon my drawings, because I doubted if they were real. This was in part because I have always noticed that no matter how near the planet, nor whatever the size of the aperture employed by other observers, they have always described the duplication as being at the extreme limit of visibility.

The first double that I recorded, Thoth, was seen as the result of an examination of some drawings kindly sent me, at my request, by Dr. Lowell. They exhibited several doubles, but Thoth was the only one I could verify at all. The following remarks were made at the time, February 18. "By looking at Thoth with magnification 300 I can get the effect, but certainly should not have thought of it as real. It is at best merely a suspicion. With magnification 660 it is less clear. Lowell's drawings were all made with powers less than 400. I should strongly doubt any fine doubles made with so low a power. Seeing 10." February 24. "Thoth still presents the double effect, but it was more marked when central. I doubt if it is really double however. Seeing 8."

Numbers 2, 3, and 4. March 3. "Protonilus and Deuteronilus perfectly straight and narrow. 8-inch aperture. Protonilus looked double, but I could not be sure of it. Seeing 8. Aryn pretty certainly there.

I believe Gehon is really double, but still not sure of it. It is seen best with the 8-inch aperture and magnification 430. I could be sure if the canals were darker, but they are exceedingly faint. Gehon has twice the separation of Deuteronilus." March 5. "I doubt if Gehon is really double yet. It is broad and rather hazy. I think both sides of it developed (*i.e.* became more distinct) tonight. Seeing 10."

Numbers 5 and 6. April 7. "Deuteronilus appears as a possible double. Gehon is wider, but more difficult. Magnification 660 is better than 850 or 430. Light yellow glass interferes rather than helps, by cutting off the light. If double, the components are extremely faint. As single bands both canals are obviously perfectly straight, and not difficult. Seeing 10. Being so narrow they clearly cannot properly be doubled, but this is as near, and perhaps nearer to seeing a duplication than anything I have heretofore detected."

Number 7. July 8. "I have been able to imagine the doubling, and the separation is easy in this case, but the lines are, as always, at the limit of vision."

Referring to the Table, we find that among the seven duplications described, Gehon was recorded three times, and Deuteronilus twice. Thoth was the most doubtful one. Excluding it, since I did not discover it independently, it will be noted that during the seven apparitions which I have observed from Jamaica, nearly completing the planet's year, in only two of them has any duplication been independently suspected. During these two the planet was near the solar longitudes picked out by Schiaparelli and Lowell as being the most favorable to seeing duplications, namely 50° and 165° (compare with column 3 of the Table). The duplication, even when narrow, (see column 7) applied only to these particular canals. In many cases the canal was noted as being remarkably straight when the duplication was seen, a characteristic often mentioned by Schiaparelli. On the other hand the most convincing of the duplications occurred when the planet was most remote, diameter 9″.5, and the separation very narrow, 0″.26 and 0″.20.

By observing two parallel dark lines drawn on white paper at a distance of 1100 feet, with the 15-inch refractor at Harvard, it was found that under the most favorable conditions, with excellent seeing owing to the short distance, the closest pair we could separate was at a distance of 0″.42. With fainter or less strongly illumined lines, this number increased very rapidly (Harvard Annals **32**, 149). It is therefore more than doubtful if so small a separation would apply to Mars. Assuming it however, with our 11-inch aperture we should have been able to separate an actual double only when the distance between the middles of its components reached 0″.57. Only the last double recorded in the Table exceeded this figure.

In order to obtain perfect seeing, and to eliminate all optical difficulties due to the use of a large telescope, thus obtaining the most favorable possible conditions, this experiment has been recently repeated

here on a small scale employing a very short distance. As was to be expected, we found that by so doing this limiting distance was reduced, but only by a comparatively small amount. Since Lowell rarely used an aperture exceeding 16 inches, and usually between that and 12, I assumed that the doubles seen by him and by myself were observed with a mean aperture of 12.5 inches, or 32 cm., that we employed a magnification of 400, and that the average double seen had a separation of 0″.3. Let us now reduce the scale of our observations 32 times. Our aperture will then be one centimeter, our magnification 12.5, and the separation of the double 9″.6. Two fine ink lines were ruled on paper 0.7 mm. apart. In order to obtain the proper separation they were placed at a distance of 15 meters or 50 feet from the objective of the telescope. They then appeared simply as a uniform blur, without any detail whatever, and could only be separated when they were brought within 40 feet of the telescope, giving a separation of 12″.0. *This angle may be taken as a constant for an aperture of one centimeter.*

Reducing this back to the 15-inch refractor, we find that even under these extremely favorable circumstances, observed out of doors in broad daylight, in order to separate a real double the separation must be 0″.32, as compared with the result obtained with the telescope, itself under especially favorable practical conditions of 0.″42. For three quarters of Lowell's canals the separation lay between 0″.30 and 0″.17. I therefore conclude that for these canals, even if they were really double, and of the width stated, with our present instruments, used under the most favorable conceivable conditions, observers could not see the components nor recognize the fact. Furthermore, no telescope unless its aperture exceeds 15 inches, can perceive a real duplication unless the separation from middle to middle exceeds 0″.40. Atmospheric difficulties, as we have seen in Report No. **35**, affect larger apertures adversely for planetary observation. We may therefore place 0″.40 as a minimum value for any telescope,—a distance eight times as great as that discernible as an elongation for a double star. We may perhaps say that separations recorded between 0″.40 and 0″.60 are doubtful to possible, and that those exceeding 0″.60 if made under favorable conditions should be accepted. No close duplication recorded however should be admitted, unless the aperture of the telescope used at the time is also stated.

Since the rods and cones in the retinas of all human eyes are of about the same size, all persons having reasonably good eyesight can separate parallel lines at about the same angular distance apart. Thus, if we draw two parallel ink lines separated by one millimeter, and view them from a distance of three meters or ten feet, we shall find them to be at about the limit of resolution. Their angular separation is then 69″. Twelve feet would certainly be the maximum distance. I tried this experiment when visiting Dr. Maggini, and later with Hamilton, both of whom are experts in seeing close double canals, and it was found as

was to be expected, that we all obtained practically identical results. Dividing our constant 12″ by 69″, we find that the equivalent diameter of the pupil of the eye in a brightly lighted room is 0.17 cm.—a result checking the constant fairly well.

The narrowest double measured on the planet by Lowell in 1903, out of 34 in all, and called by him Djihoun, had a mean width of 2°.2 or 85 miles. The narrowest one that I observed, number 4 of the Table, had the same width. This width is by no means that of a narrow canal, indeed it is rather a wide one, the distance between whose edges is clearly seen, and is readily susceptible of measurement on a drawing. This comparison of our results shows pretty clearly that we saw the same phenomenon. If one side of the canal were darker than the other, that too would be detected. What Schiaparelli, Lowell, and others failed to see however, was that by introducing two narrow canals, one on each side of the broad band, these would interfere with one another to such an extent in our vision that the whole band would merely be darkened uniformly, in case the two narrow canals were equal. If one member of the real double is darker than the other, then that side of the band will appear darker. That is the *only* effect produced. Lowell's measurements of Euphrates, Hiddekel, and Gehon, which he doubled with a 6-inch telescope, and gave respectively as 0″.27, 0″.26, and 0″.28 (Lowell Bulletin No. **5**) are absolutely impossible.

It has been pointed out by him that when Gehon doubles it is very wide, often stretching from the preceding to the following bay of the Furca, and moreover that there is no question but that these two bays are easily separable. This was quite true during the apparitions of 1922 and 1924. According to our measures made during the five apparitions from 1914 to 1922 the distance between the northern extremities of these two bays was just one-fifteenth the diameter of the planet, 7°.6 or 280 miles. Measures made from four drawings secured on July 8 and 9, 1922, when the canal was suspected of doubling (Plate III, Figure 2) gave, as we see by the last line of the Table, a somewhat smaller figure, 6°.5. Had the canals been dark, there would have been no question whatever about the duplication, because the separation, 1″.12, was obvious, and also theoretically possible to be seen. The real question however was, were there any canals there at all on either side of the wide gray streak.

When a sharply defined broad dark area on Mars lies in contact with a bright one, Hamilton and Maggini both frequently see a dark canal bounding the dark region, where the writer sees nothing but a sharply defined edge. This perhaps gives us a clew to the explanation. We can readily understand that, if the dark area is long and now becomes extremely narrow, they would see a double canal, that is one canal bounding it on each side, where the writer would see simply a single dark uniform band. The faintness of the components in every case that I observed, relatively to that of the space between them was very strik-

ing. When the canals were dark the space was dark. The difficulty in detecting the phenomenon, as it appeared to me, was not due in the least to any difficulty in the apparent separation, which latter was easily seen with such broad canals, and must necessarily have been so had there been no interference effect. The real difficulty that I found was due *only* to the lack of contrast of their darkness with that of the space between them.

Schiaparelli's description of the appearance as given in Flammarion's "Mars" leaves one with the impression that the doubling is obvious, and can hardly be missed. We have seen here, and in Arequipa, markings of which Schiaparelli never dreamed, yet we consider the duplication very near the border line of the imagination. M. Jarry-Desloges wrote me recently that in all the years that he had studied the planet, under most favorable conditions, he had personally never seen but one double. That the duplication cannot be explained simply and solely as due to the imagination however I feel quite sure. Too many practical observers have seen it. Moreover it appears clearly only at certain specified seasons, and does not affect all the canals. A characteristic of all the doubles that I have seen, was their straightness and artificial appearance. This characteristic, as we have before mentioned, was noticed also by Schiaparelli. There seems to be something peculiar about these particular canals that causes them to present the double appearance, convincingly to some observers, unconvincingly to others. This we shall now consider.

Since the actual duplication of the canal appears to be ruled out, it would seem that the surest way to discover the true explanation of the effect is to produce it artificially, and experiment with it. Unfortunately it is so fleeting an impression, or, as Lowell puts it, is such a matter of mere "flashes of revelation," that the imagination is liable to influence one's opinions too strongly to secure reliable results. I tried to imitate the phenomenon with my one centimeter aperture, by viewing narrow light gray bands of 1.0 and 1.2 millimeters in width, drawn with a number 3 pencil, at varying distances. Knowing just what to look for, I had hoped that I might be able to see them bounded by faint narrow dark lines. I cannot say that I succeeded, although several times by using a certain amount of imagination I thought that I could glimpse something of the sort. It is possible that a more practiced, or a more imaginative observer of doubles would have been more successful.

Undoubtedly the easiest celestial double canals to see are on the moon. I am not referring now to the well-known divergent double found in Aristillus, but to the extremely narrow parallel doubles located within many of what I have called the snow craterlets. These craterlets are very numerous, and when the sun is near their meridians they are intensely brilliant, like Aristarchus. A few days previous to this, a narrow black line descends their northwestern interior walls, and later disappears. With really good seeing this line in many cases appears to

PLATE III

FIG. 1
June 30, 58° Sept. 40

FIG. 4
Aug. 8, 57° Oct. 22

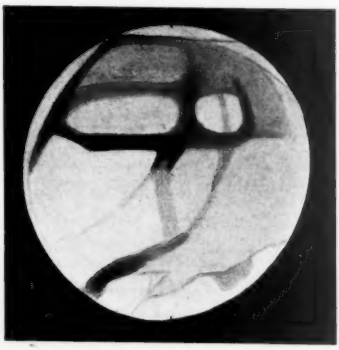


FIG. 2
July 9, 3° Sept. 49

FIG. 5
Aug. 8, 85° Oct. 22

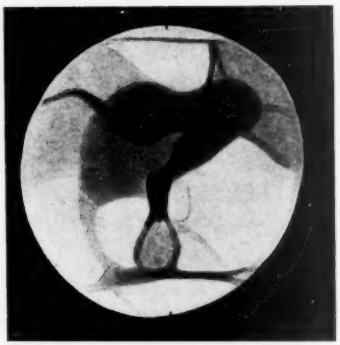


FIG. 3
July 13, 294° Sept. 53

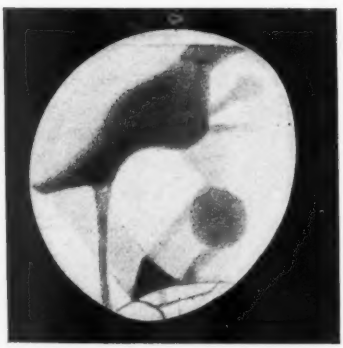


FIG. 6
Aug. 9, 49° Oct. 23

DRAWINGS OF MARS.

POPULAR ASTRONOMY, No. 342.

PLATE IV

FIG. 7
Sept. 14, 77° Nov. 3

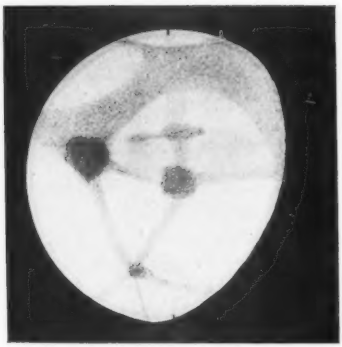


FIG. 10
Oct. 19, 86° Nov. 37

FIG. 8
Sept. 15, 56° Nov. 4

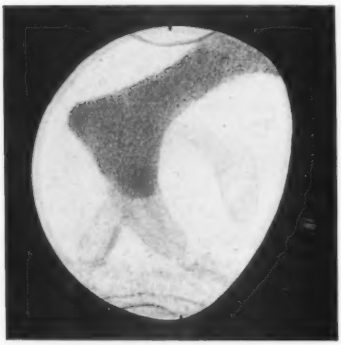


FIG. 11
Oct. 21, 68° Nov. 39

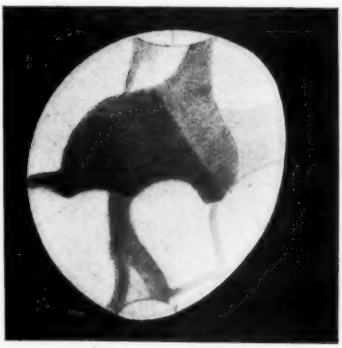


FIG. 9
Sept. 16, 43° Nov. 5

FIG. 12
Oct. 22, 58° Nov. 40

DRAWINGS OF MARS.

POPULAR ASTRONOMY, No. 342.

be double. The most convincing case that I have found lies in a small craterlet situated on the northwestern rim of Posidonius, indicated on Wilkins' 2nd edition map of 1924 by the letter B. It is perhaps 6 miles in diameter. The canal appears as early as colongitude 43°, and has been seen as late as 112°. The separation is about 0″.56, or 3400 feet. Mösting A, near the center of the moon, shows a similar double. but more difficult. It is visible between colongitudes 70° and 90°. There are many more on the moon of varying degrees of difficulty. I cannot say that any of these would be convincing to me, were it not for the one on the rim of Posidonius, which seems real, and is certainly far easier to see than any of the narrow Martian doubles. The contrast between the dazzling interior of the crater and the black canal is of course very marked. Indeed it is so strong that it might almost be compared to the case of a double star reversed, that is to say black for white. Consequently in its case the advantages secured by a large aperture should become effective, and it is possible that with exceptionally good seeing some of the great telescopes in the north could definitely settle the question whether the lunar canals are really double, or whether the effect is due merely to contrast, the bright background causing the edges of the canal to appear darker than the middle.

As a general result of my observations I may say that I believe that in order to produce the effect, a canal must be not only (*a*) fairly wide, but must be (*b*) of the proper density, and (*c*) of a preferably straight, clean cut, and artificial appearance, with (*d*) very sharply defined edges, so as to give *a full effect of contrast*. We can readily understand that, since the canals gradually change with the seasons, it will be only at certain times of the year that the proper conditions will be fulfilled. Furthermore we may say that as long as the effect is not due to a real duplication, and can probably never be clearly seen, nor accurately studied, it is not a matter of very great importance as to just why these four conditions, with the proper spice of imagination thrown in, will produce this double appearance. Possibly the snow craters on the moon may give us further information, since they at all events show it more clearly than the canals of Mars. Undoubtedly some Martian observers are much more influenced by contrast than others, and they as we have seen are the ones that see the doubles. It is hoped that this brief description may be of some use to other observers who may wish, and are trying to see this double effect, by informing them exactly what they are to look for.

Schiaparelli made comparatively few mistakes in dealing with Mars, and his name rightly carries great weight with all thoughtful Martian astronomers. Several well-known and skillful observers fully believe at the present time that these narrow canals are really double markings. I have therefore gone into the matter at some length, and described what I have seen with care. Doubtless the majority of my readers have little faith in the doubles, and some may think that much of what I

have said was merely knocking down a man of straw. I hope that this is not really the case.

The Wide Doubles.

Turning now to the question of the wide doubles, we have here something definite to study, something that we can clearly see, and something that is certainly singular, unexpected, and that cannot be explained as due to mere accident. In my observations they do not merge into the narrow ones, as far as their width is concerned, and their appearance and duration are entirely different. Lowell considered the duplications a permanent feature of the planet, their visibility varying however with the seasons. I find the duplications to be sometimes extremely brief. The separation according to my measures is never less than 10°, or 368 miles. They show plenty of contrast with the space between them, and while only seven in number, there are three other features of a similar character which indicate that duplication is a distinct attribute of Mars. Table II is arranged like Table I except that a last column is added giving the length of the canal. The first one in the table is due to Schiaparelli, although he did not describe it as a double, but gave each component a separate name. Still as shown by his map these components are certainly strikingly parallel for a surprisingly long distance. He gives no measures at all, and we can only obtain his results from

TABLE II.

Wide Double Canals.

No.	Date	☉ °	M.D.	Diam. ″	Canal	Arc ″	Deg. °	Mi.	Len.
1	1882	...		....	Gehon Indus	....	12	450	1500
2	1903	125	July 45	11.1	Nilokeras	0.91	9.8	360	1000
3	1922 July 26	198	Oct. 9	17.1	Boreas	1.52	12.0	440	800
4	1922 Aug. 9	206	Oct. 23	15.3	Nilokeras	2.55	19.1	700	700
5	1922 Aug. 8	206	Oct. 23	15.4	Ganges	1.46	10.9	400	600
6	1924 Aug. Sept.	234	Nov. 11	23.7	Strymon Achates	4.88	23.6	870	800
7	1924 Aug. Sept.	234	Nov. 11	23.7	Aethiops Amenthes	4.31	20.9	770	1200
8	1858, '62 Jun.Sep.	...		....	Margaritifer	....	20.5	760	750
9	1864 Nov. Dec.	...		....	Margaritifer	....	13.3	490	750
10	....	...		....	Furca	....	7.7	280	300
11	1913 Dec. 17	8	Mar. 17	14.5	Castorius, Propontis	2.07	16.4	600	1100

his maps. The following canals he also represents as fairly wide doubles: Euphrates 9°, Jamuna and Typhonius 8°, Titan and Phison 7°. He indicates in addition 25 more doubles ranging from 6° to 4°. I feel doubtful if any of these should be accepted as real duplications. The diameter of his objective was only 8.5 inches, or only a little more than half the aperture usually used by Lowell. The latter twenty years later records Euphrates as 4°.2, Jamuna sometimes 4°.5, but generally single, Typhonius and Titan single, and Phison 3°.5. His widths are about half those of Schiaparelli, which is perhaps suggestive of his larger aperture, and, if his measures are correct, these duplications if unchanged could not have been visible to Schiaparelli at all.

The second double mentioned in the Table is due to Lowell, while the writer is responsible for the third, fourth, and fifth. It is of interest that in the second duplication of Nilokeras, the canal is linearly twice as wide as in the first. The considerable angular widths, 0″.91 and 2″.55, makes the difference undoubted. It is proposed to discuss the third double in another Report. The measures of the sixth and seventh pair give the mean results of the four observers mentioned in Report No. **34**, Hamilton, Wilson, Trumpler, and the writer. The fourth column gives the mean date of their drawings. The parallelism of these two doubles is surprising, and cannot be due to accident, although I do not believe them to be artificial. If we turn to Reports Nos. **34** and **35**, and examine Figures 17, 18, 19, and 20 of the former, and Figure 41 of the latter, we shall find representations of each of them drawn by five different observers. Among the ten, the only drawings showing an appreciable lack of parallelism are numbers 17 and 20, of the northern double. In the former, this double is slightly narrower at the north, and in the latter at the south.

The eighth and ninth lines refer to the duplication of Margaritifer as observed by Secchi in 1858, Lockyer in 1862, and Kaiser and Dawes in 1864. This duplication probably disappeared between 1871 and 1873, although it may have appeared for brief intervals a little later, as seen by Dreyer in 1877 (Report No. **14**). The well-known Furca, whose duplication was discovered by Dawes in 1864, doubles regularly soon after the autumnal equinox of the northern hemisphere, M. D. September 23, and remains double until well into the following October, or sometimes even early January. The Martian dates on which the duplication was first detected in 1920, 1922, and 1924 were September 25, 46, and 38, corresponding to ☉ 174.0, 186°.0, and 181°.1. On the other hand in 1892 at Arequipa, it only first appeared double between ☉ 209°.6 and 212°.1, the latter number corresponding to October 32. The very early longitude in 1920, 174°.0, is a little doubtful, since the planet was rather remote, diameter 9″.2, and the duplication, 0″.6, was only suspected rather than seen. In any case, the first appearance of Aryn, ranging over about one Martian month or eight weeks, appears to be one of the most regular features of the planet's year. Since the duplication is believed to be due to a dense cloud dividing the two so-called bays, it is possible that thin wisps of cloud may produce a very faintly marked doubling at other times as has been suspected by several other observers and once by the writer himself. These two bays are about 8° degrees long at their longest.

The Castorius, Propontis bays seem to have been better seen by us in Jamaica for some reason than by other observers. The latter bay was first noticed on December 16, 1913. The other appeared the next night, and the pair are shown in Report No. **8**, Figure 14. They are very much foreshortened on account of their high latitude, but are nevertheless a very striking feature of the planet. They were seen on

six nights in December, and on four in the January presentation. There is considerable evidence that, as they lengthened, they also travelled slowly towards the west, between 200 and 300 miles in five weeks (see map in Report No. **4**). These bays were seen also by Douglass and Wilson during the apparitions of 1916 and 1918 (Reports Nos. **17** and **21**).

The apparent similarity between some of the smaller lunar and the larger Martian formations has been frequently mentioned in these Reports. In Plate III, Figure 3, drawn on July 13, 1922, we have an example of a divergent double closely resembling the Aristillus canal upon the moon. On account of the foreshortening due to its high latitude it is really much less divergent than it appears. It extends between latitudes —66°.1 and —30°.5 over a distance of 1300 miles. The components diverge at an angle of 10°.1, and their maximum separation from middle to middle is 6°.5 of a great circle, or 240 miles, a

TABLE III.

FUNDAMENTAL DATA OF THE FIGURES.

Fig.	1922	Magn.	Seeing	Long.	Lat.	Diam.	☉	M.D.
				°	°	″	°	
1	June 30	430	9	58	+ 9	20.0	182.6	Sept. 40
2	July 9	430	9	3	+10	19.2	187.8	Sept. 49
3	July 13	430	10,9	294	+10	18.7	190.1	Sept. 53
4	Aug. 8	430, 330	10	57	+ 8	15.4	205.7	Oct. 22
5	Aug. 8	430, 330	8	85	+ 8	15.4	205.7	Oct. 22
6	Aug. 9	430	7,9	49	+ 8	15.3	206.3	Oct. 23
7	Sept. 14	430	9	77	+ 1	11.6	228.6	Nov. 3
8	Sept. 15	430	9	56	0	11.5	229.2	Nov. 4
9	Sept. 16	430	10	43	0	11.5	229.9	Nov. 5
10	Oct. 19	430	10	86	— 9	9.2	250.8	Nov. 37
11	Oct. 21	430	9	68	—10	9.1	252.0	Nov. 39
12	Oct. 22	430	11	58	—10	9.0	252.7	Nov. 40

trifle less than that of the Furca, which is 280. Lowell once recorded Arnon near the north pole similarly divergent as it approached a lower latitude. The canal is interesting because whether natural or artificial the components are here obviously related to one another, and appear to be distributing the water, from the polar cap by means of gravity, during the spring of the year (for the southern hemisphere), M. D. September 53, from a common source in the south. One component leads towards Euxinus in the Syrtis major, the other towards Sabaeus. These are frequently the two darkest areas on the planet, and were so at this time.

The remaining figures all refer to the same region. In Figure 4 we recognize Solis on the right near the western, or sunrise terminator, Aurorae and Lunae on the central meridian, and Acidalium carrying a little elongated lake, to the south of the northern polar cap. On the eastern side of the cap we notice one of those high polar clouds, referred to in several previous Reports. Ganges is clearly shown connecting Lunae with Aurorae. It is of interest because it will be noted

that it is distinctly narrower towards the southern end. Another drawing not shown was made an hour later. It differs but little from the previous one, save that Ganges has widened somewhat near Aurorae, and Nilokeras, joining Acidalium to Lunae, is also wider. On the same date, just two hours after Figure 4 was drawn, we secured another drawing, Figure 5. Lunae it will be seen, owing to the rotation of the planet, has moved towards the left, and it is noon there now. Regions to the east, or to the left of it, have faded out under the dense mists of the limb, while regions towards the sunrise terminator have appeared that were not recorded before. Ganges is seen to have doubled.

That it was carefully drawn in the two previous representations is shown both by its unusual shape, and by its gradual widening in the second drawing. The process of duplication has always been considered mysterious by those who have recorded it, and it has been suspected of being sudden. Schiaparelli has mentioned cases where it developed in the course of twenty-four hours, but his remarks applied merely to the narrow doubles. A real duplication of a wide double, separated by an interval of 1″.46, as shown in Table II, occurring within an hour is believed to be a record. Of course it is possible that this was due to the clearing away of invisible cloud, and just before Figure 5 was drawn it was recorded that a cloud was seen preceding Lunae. This fact may have some bearing on the phenomenon. The eastern canal in this case was the fainter. The western denser one formed by the side of it. In the drawing showing the duplication the seeing was 8, while in the earlier one it was 10, so there can be no doubt but that the change actually took place.

That the duplication was not permanent we see by Figure 6, taken on the next day, about half an hour earlier in the morning than Figure 4. Ganges is again hazy and indistinct, the southern end now being wider than the northern. An hour later however the duplication again formed as on the previous day, but this time the two components were not parallel. At Lunae they were the same distance apart as before, but only 0.6 as wide at Aurorae. Moreover the duplication was now apparently carried down the whole length of Lunae, and stopped when it got to the end of it. Here the canals were perfectly parallel and straight, a bend occurring in the eastern canal but none in the western. This drawing is not shown because it is incomplete. A thin haze was prevailing, which prevented our seeing clearly the fainter detail. When clear the duplication was certain, although faint. The varying coloration of the various regions was rather marked. Lunae was brownish gray, the maria green, Tithonius and Acidalium gray, the southern snow yellowish white, and the northern "snow white."

It appears that on both of these dates in August the duplication did not appear until towards Martian noon. We have unfortunately no means of knowing how late in the afternoon the duplication lasted, since we had bad weather on the previous nights, but in any case

it would have probably disappeared before the canal reached the limb. The only other drawing that we possess showing the duplication of Ganges was made a month later on September 15, Figure 8. This time it occurred well before the Martian noon, and the width was clearly less, only 0″.7, or about 260 miles. The previous night, Figure 7, there had been recorded the effect of a heavy Martian storm, darkening the soil of all the deserts in that vicinity. Lunae is shown as a perfectly round dark spot, just past the central meridian. The other spot is located on the coast line, between Aurorae and Margaritifer. The dark band connecting them is Ganges. When the deserts had dried off, Ganges doubled, and the other canals appeared. Diameter of Mars 11″.5, seeing 9.

Lunae it will be seen had now extended 500 miles to the east, at a speed of 20 miles per hour, the slightly curved canal extending it further is first shown in Figure 4, but is now much more strongly marked, and is joined to the polar cap on the north, and to Margaritifer on the south, by broad bands. The next night, September 16, Figure 9, still further changes occurred. Lunae being on the terminator is not recorded, while Ganges, joining it to Aurorae, appears as a single and rather narrow canal. Again its duplication appears to be of a very temporary character unlike the narrow doubles of Schiaparelli and Lowell. The changes in the appearance of Ganges on the three successive September nights are certainly striking, and rather suggestive.

The only drawing that we have of Nilokeras as a double was made on August 9, Figure 6. None of the three drawings made the previous night, except for their continuous widening of the canal, suggest anything of the sort. The duplication it will be noticed, like that of Ganges in September, occurred in the early morning. It was very wide, the outer edges of the canal being tangent to the circumference of the circular Lunae. The western member is a little darker towards the polar cap. Each member is about one quarter of the width of the canal as measured from middle to middle of each component. They are each about 170 miles wide, and the western member in this case coincides with the original canal of Figures 4 and 5. Proceeding from Acidalium to Thymiamata, which lies between Furca and Margaritifer, we see a long straight meridional band, of about the same width and density as Nilokeras, but without its bounding canals. Since this band was really straight and very wide, as appears on a drawing made August 11, it is evident that in this figure it should have been curved, and nearly parallel to the limb. Under the rather unfavorable conditions of lighting, position, seeing, clouds, etc., under which all drawings at the telescope are made, such accidental errors are occasionally almost unavoidable. The important fact to note however is that this band has no bounding canals. It appeared again in September, but is best shown in Figure 9, where it is much narrower and darker. At the June, July presentation of this region, which preceded the August one,

Ganges was a narrow, clearly defined, single canal. Nilokeras was occasionally sharp, but sometimes broad and faint, Figure 1. The curious shape of Acidalium is noticeable. On October 21, Figure 11, Jamuna was broad with a well defined component on its western side, but with none on the other. The western side of all these canals is the darker. Figures 1, 4, 8, and 12 were drawn at successive presentations of the planet, and all have practically the same central meridian. Still another drawing was made of the region on November 24, M. D. December 17, central meridian 64°. In this a dark area is shown over Aurorae much like that in Figure 10, except that it is nearly twice the size. Ganges is decidedly wider, much as it was in Figure 7, only now it reaches the polar cap, instead of stopping at Lunae.

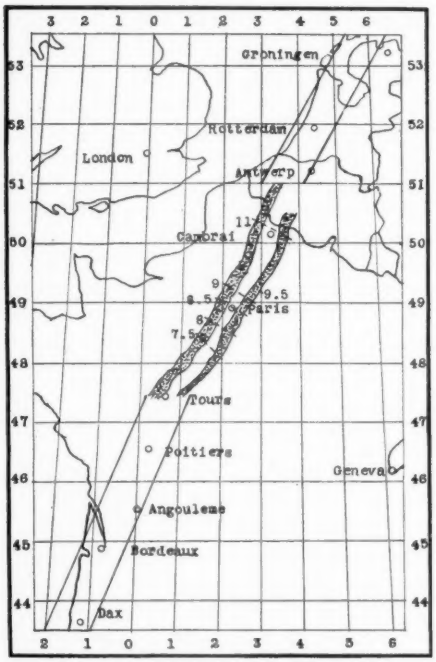
These are all the facts that we have learned in connection with the double canals. The suddenness with which the duplication forms, and the shortness of its duration, in some cases, should aid us somewhat in its interpretation. The fact that one appeared in connection with a cloud, and another immediately after a general surface darkening, which we have interpreted as indicating the result of a wide-spread rain storm, implies the darkening of a desert region by rain, rather than by vegetation. Why the lines should be duplicated it is not easy to see, but we may recall that even in this matter we have some terrestrial analogies. Accompanying our cyclonic storms in the west, we sometimes find a group of tornadoes which move in straight, narrow, parallel lines, although often they may be many miles apart. An instance still more to the point occurred nearly one hundred and fifty years ago in France, in connection with a shower of hail. That a hail storm occurring so long ago as that could in any way throw any light on what we see at the present time occurring on a neighboring planet, certainly appears at first sight a little surprising. Fortunately this storm was so thoroughly and accurately observed, that it might well serve as a model of observation for similar occurrences at the present day.

The Great Storm of July 13, 1788.

This storm swept over the most populous portions of France, and caused the people such severe losses, chiefly through the hail that accompanied it, that it has been noted as one of the contributing causes to the French revolution. It is described in two articles in the "Memoires de l'Academie des Sciences" for 1789 and 1790 by Messrs. Leroi, Buache, and Tessier. Hailstones as large as hen's eggs were not uncommon, and a few were found measuring nearly three inches in diameter. Some weighed half a pound. In places they were swept by the accompanying wind into drifts over two feet in depth. The noise made by their fall was terrifying, and prevented one from hearing the accompanying thunder. The clouds from which they fell were very low, extremely black, and advanced with frightful speed. The rain was very heavy, but the hail only lasted seven or eight minutes. Partridges,

rabbits, and sheep were killed, but no human beings, although a number of the latter were badly bruised.

A map was prepared in three sections which I have united in the accompanying figure, changing only the longitudes to the present standard. In the middle and best known section the hail fell in a double band, the space between receiving only a heavy rain, which did good rather than harm. Some rain also fell for a short distance on either side of the double band. The width of the two components varied in different places, but they remained approximately straight and parallel.



The Great Storm of 1788.

The distribution of the hail in the northern and southern sections of the map is unknown. The middle section was 300 miles in length, and averaged 40 miles in width. The total length of the storm as mapped is 800 miles, or 20 times its width. In certain places the time of the coming of the hail was noted, and where these times check one another on the two bands, so as to inspire confidence, cross lines have been drawn, and the Paris time entered on the map. The hail reached the Zuider Zee at $2^h\ 30^m$. In the middle section the hail fell in the morning. The storm advanced from the southeast, and travelled at a fairly uniform speed of 45 miles per hour. In the western band it was accom-

panied by a wind so severe as to break and uproot large trees, and damage houses and churches. There was no evidence of a whirling action, the trees all falling towards the northeast. The western band, it will be noted by the map, was also wider, as in the case of all the Martian doubles.

The double band of hail stones, by its shape and appearance, naturally suggests to our minds an analogy of some sort with the gray double canals of Mars. Had the hail formed at a great elevation, as might have been the case in the dense, extensive Martian atmosphere, and reached the warm surface after a fall of considerable duration, in the form of water, we might well have had two dark parallel bands traced on our own planet. This would have been particularly the case had the soil been barren and parched as in a desert.

But there are other points of interest in this storm. We find that the rain only fell for a short distance on either side of the double band, which gives us a clew to the width of the storm. This width was greater than that of many of the Martian canals, although appreciably less than that of the wide doubles, while its length was a fair average of them. Its direction too was Martian, and quite unlike our usual storms, which generally follow a more or less east and west course. Its straightness, also Martian, was quite remarkable, considering its narrowness and great length. It curved slightly towards the right, which was the proper direction for the northern hemisphere, but had it been in a higher latitude it must have curved more. Its observed radius of curvature was fully 5700 miles. From it we may draw the conclusion that a straight temporary canal on Mars furnishes no argument in favor of artificiality, while a permanent straight canal on the other hand, implying vegetation, may and perhaps does do so.

The Dark Circular Areas.

It has sometimes been suggested that the small lakes on Mars were not really circular as drawn, but only appeared so because they were so small. This argument however does not apply to the larger spots, such as Lunae, which is often perfectly round, as shown in Figures 6 and 7, and Tithonius near the center of Figure 10. Lunae frequently retains its rounded form for weeks at a time, but the other large round spots are only temporary affairs, lasting for but a few days or hours. These latter are quite uncommon, and are undoubtedly the most difficult features to explain of any that are found upon the planet. Perhaps the most interesting one ever recorded was first seen here at 13^h G.M.T., July 9, 1922. It was then central on Pandora, in the immediate vicinity of the Horarum promontory, in latitude —26°.5, longitude 32°.7, and near the terminator. In a couple of hours it had greatly increased in size, had developed a large white spot, presumably cloud, at its center, and had apparently travelled 300 miles towards the north. It was then recorded by several other observers. By the next night the white area

had become irregularly triangular in shape, and had moved in 25 hours 550 miles north and 250 miles west, at a speed of 24 miles an hour. When its location was favorably placed on July 8 there was no trace of it to be seen. On July 11 when Oxia was within 25° of the central meridian no evidence of the spot was visible. It had therefore apparently vanished, and had been visible for less than two days. It is fully described in Report No. **30**. It may be of interest to note that the dark spot shown near the limb in Figure 7 lies near the track, and halfway between the two positions of the white spot above described. It may be the source of the extension of Lunae towards the east, since winds having a component towards the east are almost, if not quite, unknown on Mars. Its approximate position is in longitude 50°, latitude —6°. Should any observer be fortunate enough to see one of these round dark spots in the coming years, it should be watched as carefully and continuously as possible, and its darkness and size, as well as its location, should be most carefully determined for possible motion. Whether in this case the dark spot itself moved, or simply the cloud depositing fresh moisture as it went caused the apparent motion, we cannot say. The latter appears the more probable. That the spot itself really moved 300 miles in a couple of hours when first visible is certainly surprising. The upper air currents, as we found in Report No. **19**, apparently do move at speeds of 100 to 200 miles an hour. Whether this motion ever extends down to the visible clouds we do not know. It is possible that these round spots are due to moisture deposited on the soil at night, but why they should be so accurately circular unless artificial, remains a mystery. Have the Martians on the other hand some means of drawing large supplies of water from the interior of their planet? Can the tapping of submartian water courses explain some of the canals? If so, most of the water is certainly evaporated, and goes into the general atmospheric circulation. Unless that is what they want to do, to dampen their atmosphere, this to terrestrial eyes would appear to be unnecessarily wasteful, but doubtless we should be doing the Martians an injustice to suppose that they were as wasteful as ourselves.

As to the size of these round spots, Lunae on August 9 was 900 miles in diameter. The other spots range from 500 miles down. Three of varying size are shown in Figure 10. Lunae is there quite small, but two days later in Figure 11, and in another drawing not shown, the two southern canals in Figure 10 leading to it, or from it, have widened markedly. Lunae itself has disappeared, and we see that in Figure 12 one of the canals has narrowed again appreciably, as if the moisture had evaporated. Although we are slowly learning, step by step, and find it intensely interesting, we see that we are as yet far from having anything beyond the most elementary meteorological knowledge of our most attractive planetary neighbor.

Private Observatory, Mandeville, Jamaica, B. W. I.,
November 20, 1926.

THE MOON ILLUSION.

[*We regret that we are unable to assign to this paper its authorship. The manuscript reached us bearing only the initials D. M. P., the envelope being postmarked Woronoco, Mass. As it is an interesting and, as far as we know, a new discussion of an old question, we wish our readers to have the benefit of it. Perhaps the writer of it will see it here and communicate with us. We hope so.*—Ed.]

Nearly everyone has been impressed by the fact that the moon (or the sun) looks remarkably larger when it is near the horizon than when it is high in the sky. This phenomenon is of course exaggerated in certain examples of romantic art, wherein the rising moon is painted as almost big enough to cover up the Great Bear. In point of fact, the greatest amount of illusion is about 2.5; that is to say, in tropical latitudes (where the moon can reach the zenith), the moon's visual diameter is decreased in the ratio of one to two and one-half as it passes from the horizon to the zenith.

This curious phenomenon has puzzled science for two thousand years. It has engaged the attention of some of the acutest thinkers of all times—Aristotle, Ptolemy, Alhazen, Roger Bacon, Kepler, Descartes, Huyghens, Berkeley, Euler, Gauss, Helmholtz and many other astronomers, physicists, psychologists and philosophers, and they have advanced many theories to account for it. Only very recently has it been decisively shown in what direction the correct explanation probably lies.

The earliest recorded theory, that of Aristotle, refers the effect to a physical cause. He supposed the atmosphere to bring about a divergence of the light passing horizontally. Photographs of the moon, however, readily show that the true explanation cannot be physical; the image is actually smaller when the moon is on the horizon than when it stands in the zenith, for in climbing to the zenith it comes nearer to the observer by one earth-radius. The peculiarity is in the observer and not in the light.

The explanation given in most text-books is the one favored by Helmholtz: The moon at the horizon, being seen in the neighborhood of terrestrial objects, gains size by virtue of comparison. Anyone who will take the trouble to make the observation, either of the rising moon at sea or of the culminating moon when it is just above a tall building or a mountain, can easily satisfy himself that the illusion is not to be accounted for in this fashion. Surrounding objects have little if any influence. The theory of Ptolemy and Descartes, that the illusion is due to the emphasis given to the moon's distance by intervening objects, is likewise refuted by observation.

Another explanation (given by Alhazen about the year 1000) appeals to the shape of the celestial dome. The sky is not a hemisphere but is flattened above us. It would seem logical, then, that we should judge

the moon to be farther from us when it is on the horizon, at the base of the dome, than when it is overhead, on the flattened top. But we credit an object with more size the farther away it appears to be—so runs the explanation. Thus the horizontal moon should be relatively big. But Claparède and Zoth questioned 120 people in regard to the apparent distance, and 116 answered that the moon seemed not farther, but nearer, when at the horizon. Thus another hypothesis was disposed of.

Henning made the suggestion that the longer wave-lengths of the light received from the horizontal moon might in some way increase its visual size. But observations of the overhead moon through red and yellow glasses showed no increase in its dimensions.

Recently, a careful study of the moon illusion has been carried out by Erna Schur[1] of the University of Berlin. She determined to find out whether the effect was peculiar to astronomical bodies, or whether it could be obtained terrestrially with an "artificial moon." A magic lantern was so constructed as to project two circular spots of light, one horizontally, the other vertically above, at equal distances from the observer. The sizes of the spots could be regulated by means of diaphragms in the lantern. One spot being given a fixed size, the experimenter adjusted the size of the other until the observer decided that the two looked equally large.

Experiments were conducted first in the laboratory, next in a theatre, next in a large church, and finally in one of the great airship hangars. Thus it was possible to carry out a series of observations at distances up to 108 feet.

Even at small distances the illusion was quite obvious. At 10 feet the vertical and horizontal spots appeared equal to the observer although their measured diameters were in the ratio of 1.16 to 1. At 108 feet the ratio was 2 to 1—the vertical "moon" was mathematically twice as great as the horizontal but to the eye they were equal. Different observers agreed in their estimates with reasonable consistency.

The amounts of illusion when plotted against the distances lay upon a smooth curve. The illusion increased slowly as the distance increased, then very rapidly, and then slowly. It appeared probable from the curve that there is a certain distance at which the illusion reaches its greatest possible value which it retains for all greater distances. If the curve were extended beyond the limit of observation, it could be inferred that this limit would be reached at about 230 feet, and the illusion would then have the full value, 2.5, which one observes in the case of the real moon. Unfortunately no 200-foot room was available for the experiments.

The moon illusion is then simply an illustration of a general principle: that any object looks smaller when we have to look up at it than when we see it directly in front of us.

[1] *Psychologische Forschung*, Oct. 1925.

The correct explanation seems to be that originally proposed by Gauss, which ascribes the effect to eye-movement. When we have to converge our eyes to look at an object, that object appears relatively small. (This fact has been proved experimentally.) Now when the head is turned towards an object overhead, by virtue of the arrangement of the eye-muscles a slight divergence of the eyes takes place automatically and in all circumstances. We have to overcome this divergence, *i. e.* impress a compensatory convergence upon the eyes, in order to fixate the object. But the visual size of the object, according to our law, is thereby reduced. Thence results the small size of the overhead moon.

With near objects of course there is a strong eye-convergence already present, and the change of convergence associated with the direction of vision is comparatively little. But when we look at a distant object like the moon the eyes are parallel, and the effect due to head rotation plays a noteworthy role.

On this interpretation, we should not think of the horizontal moon as "too large," but of the high moon as "too small." The large moon is the "normal," the small moon the "illusory" phenomenon.

Why should eye-convergence cause a reduction in apparent size? The following explanation has been put forward: The energy-stream in the nervous system which carries our optical perception of the moon may behave somewhat like a liquid film under surface tension. The energy necessary to effect the convergence of the eyes is drawn out of this perception-stream, and the stream thereby contracts; thus the perceived size of the moon is diminished. The behavior is analogous to that of a rubber balloon filled with air; if we abstract heat-energy from the contained air, the balloon will collapse somewhat. So also a liquid membrane, when cooled, draws itself together.

Two possible checks on the eye-movement theory suggest themselves. First, we might reflect the overhead moon to the horizon by means of a mirror inclined at 45 degrees. The reflected image should then be equivalent to a rising or setting moon, and should look larger than the real moon in the sky. Or we might reflect the horizontal moon overhead, and it ought to be reduced in size.

This experiment was tried, but a new and complicating phenomenon at once came into view. It was found that for some unknown reason a plane mirror, in and of itself, always produces a diminution in the size (to the eye) of an object which it reflects. Hence in the first case mentioned above, the reflected image looks just about equal to the true moon overhead; the mirror compensates for the enlargement. In the second case, the reflected image is abnormally small, and the illusion is much more marked than one would expect.

Secondly, one might try the device of lying on the back to compare the artificial moons. But here again it appears that another factor comes into play. The eye-reflexes are dependent upon the position of the

whole body, as recent physiological research has shown. They are not the same when one lies on one's back as when one stands upright. The illusion is not, as would be expected, destroyed for recumbent observation, but is merely reduced, for an involuntary divergence of the eyes still takes place when an overhead object is regarded, and this time by virtue of the bodily orientation. This divergence is probably brought about by nerve-impulses from the organs of equilibrium.

Such at any rate is the most satisfactory solution which has been achieved after twenty centuries of speculation on this ancient moon-riddle.

AMERICAN ASTRONOMICAL SOCIETY.

REPORTS OF OBSERVATORIES
1925-1926

[*Continued from page 35.*]

DEARBORN OBSERVATORY

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS

The year has been one of excessive cloudiness, seriously reducing the total of observing hours. Only 241 plates were exposed on the stellar parallax program. A total of 272 observations of double stars was made as against 804 of the previous year. The discrepancies may be offset in part by the hours which have been diverted to the stellar spectrograph. Numerous plates have been made for the testing and adjustment of this instrument and about 130 acceptable stellar spectrograms.

The director and Miss Bennot have given the major part of their office time to the preparation of the Observatory's stellar parallax results for the printer. Numerous errors in computation have been discovered in the course of critical examination of the many fields, not infrequently necessitating complete recomputation, and thus retarding the completion of the manuscript. Mr. Paddock has directed his effort to the stellar spectrograph, and also has measured some parallax fields.

The members of the staff are charged also with the instruction in astronomy in the College of Liberal Arts and in the Graduate School. Three courses were given in each semester. The period of the report includes the opening of the Summer Session of the University. Professor Dinsmore Alter of the University of Kansas, as visiting professor, gave the instruction to undergraduates. The research course was

conducted by the regular members of the staff. As graduate students or volunteer research assistants Professors William R. Ransom of Tufts College, H. B. Curtis of Lake Forest University, and Helen Whitaker of Washburn College were in attendance.

Visitors have been admitted to the Observatory on clear Thursday evenings, as in other years. The number admitted aggregates about three thousand.

PHILIP FOX, *Director.*

DOMINION ASTROPHYSICAL OBSERVATORY
VICTORIA, BRITISH COLUMBIA

Staff. No changes occurred during the year in the permanent staff. During the summer vacations Mr. W. H. Christie and Mr. R. M. Petrie, both university students, assisted in the observing and measuring.

Observing. The weather for the twelve months ending June 30, 1926, was considerably above the average, a total of 1872 spectrograms being secured on 216 nights. The seven-year average shows 1653 plates on 206 nights. Dividing the nights of this past year into two classes, as poor, when less than five plates, and fair to good, when more than that number were secured, we have 64 nights with 156 plates, and 152 nights when 1716 plates were secured. A few of these, as in previous years, were long-exposure spectra of nebulae or faint stars, but apart from such the spectra secured were of stars on the regular programs using the single-prism instrument with both a medium and short-focus camera. As in former years for two hours on each Saturday night the telescope was placed at the disposal of the general public when celestial objects of popular interest were shown. This feature has proved to be quite a popular one, especially during the summer tourist season when from 200 to 300 are present.

Programs and Results. The program of observation of the B-type stars, which has been under way for two years, is making satisfactory progress, more than half the spectra required having been obtained and the velocities of about 200 of the B stars being completed. Satisfactory progress also can be reported on the A-type program undertaken with the primary aim of determining absolute magnitudes. Some new lines sensitive to absolute magnitude were discovered and some preliminary results were given before the Royal Society of Canada in May. Before any results are published it is hoped to secure spectra of all A-type stars on the general program made out some years ago listing all within reach between magnitudes 6.0 and 6.5. The radial velocities of these will be required for statistical treatment and they are being measured as the plates are secured.

In following out these programs a number of spectroscopic binaries have been discovered and considerable observing time has been spent

upon these. The following twelve orbits have been completed this year and are either published or in press: 12 Lacertae, σ^2 Coronae Borealis, H.R. 7267, 21 Cassiopeiae, Boss 3354, H.D. 191201, Boss 1275, H.R. 2962, H.D. 1337, H.R. 6506, H.R. 5752, and H.R. 5702. In 12 Lacertae the change in amplitude previously noted is found to be very rapid. The second and third are double-line F-type stars with minimum masses 2.0 and 2.5 times that of the sun. The star 21 Cassiopeiae is an eclipsing variable in which the photometric orbit at Madison and spectroscopic orbit here were obtained nearly at the same epoch. Both orbits are accurately determined and the coincidence of spectroscopic and photometric phases indicates that the discrepancy found in other Algol stars is due to accidental error. H.D. 191201 and H.D. 1337 are massive O-type stars showing both spectra and yield minimum masses for the systems of 26.7 and 34.5 times the sun. The last mentioned star is an eclipsing variable, and we learn by combining the spectroscopic and photometric data that it is the largest and most massive eclipsing system known. The actual mass is 70.1 times the sun, the temperature 28,000°, the absolute magnitude —6.3 and the parallax 0".00032. In addition to these orbits the measures of 48 H.R. stars were published. A large number of plates were obtained of three stars whose spectra were found to be variable and peculiar and considerable time was spent upon the interpretation of these peculiar cases. The total number of plates measured for radial velocity for all purposes was 1444 and thus measurement has kept in fairly close touch with observation.

High-dispersion spectra of Vega and the sun were secured to determine the absolute residual intensities of the absorption lines. Some preliminary measures have been made and a modification of the microphotometer, designed for the final accurate measurement, has been constructed. Methods of observation have been devised also to eliminate the errors revealed in a critical study of the wedge method.

A revision has been made of the absolute intensities of the lines in the Orion nebula and N.G.C. 7027 and part of a paper on nebular spectra has been prepared.

Publications. There were issued during the year as *Publications of the Dominion Astrophysical Observatory,* Volume III, numbers 9 to 11 inclusive and three more are in press. Our mailing list has been revised, some 40 institutions being dropped and 110 others added to the list.

J. S. PLASKETT, *Director.*

DUDLEY OBSERVATORY

ALBANY, NEW YORK

One of the chief objects of the program of observations undertaken at Albany and San Luis was to provide a means of forming a homogeneous system of star places extending from pole to pole. To provide for this desideratum three important features were introduced: first,

the employment in large part of the same observers at both stations; second, the use of the same instrument; and, third and most important, the observation of stars throughout a broad region of the sky common to both stations. This program furnishes an excellent opportunity, through intercomparison of observations north and south of the equator, to free the observations from systematic errors which could not be determined from observations taken at either station alone. The reductions of the San Luis observations were completed some time ago and the Albany reductions have now reached a stage sufficiently advanced to make intercomparison possible. Messrs. Boss and Jenkins have shown that not only is it possible to harmonize the observations north and south of the equator, but considerable light has been thrown on the conditions of refraction at both stations. The errors in declination which depend upon declination are assumed to be due to uncorrected flexure and refraction, flexure being represented by a sine term and refraction by tangent terms. It is evident from the observed results that a simple tangent term will not suffice, so higher orders of the tangent were used. The adjustment of the two sets of observations upon this assumption produces an agreement which must be considered remarkable when we consider that the position of the south pole, as derived from the San Luis observations, was taken as absolute in defining the San Luis meridian and that similarly the north pole derived from the Albany observations was used to define the Albany meridian.

Systematic corrections to the *Preliminary General Catalogue* have been determined from the combined Albany-San Luis observations. The corrections to the right ascensions depending upon right ascension are in accord with those determined from recent observations at other institutions. The corrections to the declinations depending upon declination come out somewhat larger than those derived last year by Raymond from a large number of catalogues but bear out his general conclusions.

Mr. Raymond has determined corrections to the *Preliminary General Catalogue* in declination depending upon right ascension, basing his study upon 43 of the better fundamental catalogues. The general impression that errors of this type are small is confirmed.

Mr. Wilson has made a study of the space motions of 348 Class B stars. His results bear out earlier conclusions based upon radial and proper motions that these stars tend to move more nearly in the plane defined by their positions on the sky, a plane which is inclined at a small angle to the galaxy, than in the galactic plane itself, and that their preferential motion is along an axis almost coincident with the direction of the solar motion. The results differ from those of earlier investigators in indicating that preferential motion is but little less marked among these stars than among the stars of other spectral classes, and that the avoidance of motions toward the poles of the B-type plane on the part of these stars is about the same as the avoidance

of motions toward the galactic poles on the part of stars of other classes. It is further noted that the high-velocity stars of this type show the same tendency as the high-velocity stars of other types in their avoidance of motions toward the first galactic quadrant.

Mr. Albrecht has completed an extensive list of observed wave-lengths for the B-type stars, based upon published and unpublished measures of 3-prism spectrograms taken at the Yerkes Observatory and re-reduced on a homogeneous basis with the use of the best recent laboratory wave-lengths. He has also shown that systematic errors in the wave-lengths used in the determinations of radial velocities will account for 1.4 km of the K-term of +4.0 km peculiar to these stars and has discussed the possible effects of convection currents and relativity shift in accounting for the balance.

Messrs. Raymond and Wilson were joint recipients of the gold medal of the Danish Academy of Sciences, which was offered in competition for the best solution harmonizing the discordant results for the motion of the sun in space as derived from radial velocities and proper motions.

BENJAMIN BOSS, *Director.*

LEANDER McCORMICK OBSERVATORY

UNIVERSITY OF VIRGINIA

The general work of the Observatory has continued with little changes. Mr. Piet van de Kamp again became a member of the Observatory staff on October 1, 1925. He is continuing the work on the proper motions of Boss stars from the measurements of plates taken with the 26-inch refractor. Mr. Alexander Vyssotsky continues as a member of the staff. In addition to work on the parallax program, he is engaged in proper-motion discussions of stars in selected regions.

During the summer of 1926, the director spent two months at Mount Wilson in furthering for publication his investigations of the flash spectrum. Spectra at the 1925 eclipse increased the extent of the region under investigation from wave-length 3200 to 7100 A in the red. From the rich material available at Mount Wilson it is planned to discuss the flash spectrum in order to establish correlations between the heights in the chromosphere, with consequent variations in temperature and pressure, and the levels displayed in the atomic structure.

At the Cambridge meeting, Mr. Olivier was made the chairman of the Commission on Meteors of the International Astronomical Union.

S. A. MITCHELL, *Director.*

DETROIT OBSERVATORY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN

Instruction. A considerable portion of the time of each member of the staff is devoted to the work of instruction. In the interval considered in this report, M. L. Zimmer and D. W. Lee completed their

work for the doctor's degree; O. L. Dustheimer and Dean B. McLaughlin were actively engaged in work on their theses for the same degree.

To facilitate the work of instruction, space has been occupied in the new building of the College of Literature, Science, and the Arts and equipment installed for an astronomical laboratory. For this purpose a ten-inch refracting telescope has been received from the Warner & Swasey Company of Cleveland, Ohio. It is expected that a second telescope of comparable size and two transit instruments will eventually be added to this equipment.

Research. Observations with the single-prism spectrograph attached to the 37½-inch reflector were continued through the year, and 511 spectrograms were obtained, making a total with this instrument of about 7300. The principal program related to stars of Class B, with emission line spectra, north of —20° declination. Intensive observations have been continued on a number of ϕ-Persei spectrum variables. A second program of observations of Class-O binaries was continued in the case of ξ Persei, A Cygni, and BD +56°2617. A third program included the observation of twenty intrinsically brighter stars of Classes F0 to K0, to study changes in wave length with spectral class over the spectral range of the brighter Cepheids. This is being done to aid in the interpretation of wave-length variations synchronous with the light changes of Cepheid variables.

Studies of velocity curves with especial attention to irregularities due to rotational velocities during partial eclipse have been continued in the cases of Algol, λ Tauri, and δ Librae.

Spectral studies of ϕ Persei, δ Cephei, ζ Geminorum, H.R. 985, b_2 Cygni, κ Draconis, χ Ophiuchi, ν Cygni, ν Sagittarii, Nova Geminorum 1912, Nova Aquilae 1918, Nova Cygni 1920, and other objects were also carried on during the year. Papers on Class Be stars and W Sagittarii were published during the year.

Those engaged in the spectroscopic observations and investigations were the following: R. H. Curtiss, W. C. Rufus, R. A. Rossiter, O. L. Dustheimer, D. B. McLaughlin, D. W. Lee, W. L. Metcalf, M. K. Jessup, H. F. Donner, S. W. Taylor, and Miss Frances L. Seydel.

Professor M. L. Zimmer of the National Observatory at Córdoba was engaged in research at the Detroit Observatory from February to August, 1926. He was occupied principally with the preparation of a thesis on the Determination of the Right Ascension of Fifty Southern Circumpolar Stars and with experimental studies of the problem of registration of star transits automatically. During the summer session other visitors engaged in work here included Messrs. O. L. Dustheimer of Baldwin-Wallace College, J. B. Winslow of Toledo University, D. E. South of the University of Kentucky, W. J. Williams of Baylor

University, and Miss Alberta Hawes and Miss Laura E. Hill both of Vassar College.

In February, 1926, Mr. M. K. Jessup and Mr. H. F. Donner were made Lamont assistants in preparation for double star observations in Africa. Mr. Curtiss, on leave of absence from February to June, 1926, carried on studies and investigations at Mount Wilson, Lick, and Yerkes Observatories.

The Lamont 27-inch refractor was completed and erected on a temporary pier in October, 1925. Tests on the stars covering a number of nights confirmed the laboratory tests in proving the excellence of the objective. As was expected in a large lens exposed to the weather without shelter there were zonal differences in focus shortly after dark. But with settled conditions later in the night these were so far removed that Mr. Hussey felt satisfied that the figure of the lens was sensibly perfect. The mounting was found to be entirely successful and, with the exception of minor details, ready for regular use.

This report can not be concluded without briefest reference to events subsequent to July, 1926. The death of Professor William Joseph Hussey, director of the Detroit Observatory since 1905, occurred on October 28, 1926, in London while en route to Bloemfontein, South Africa, to establish a southern observatory. Mr. R. A. Rossiter who accompanied Professor Hussey on this expedition is proceeding to Africa to continue the project as planned.

R. H. Curtiss, *Acting Director.*

MOUNT WILSON OBSERVATORY

Carnegie Institution of Washington

Pasadena, California

Staff. The scientific staff of the Observatory has remained without essential change during the year. In the computing division Dr. Hazel M. Losh and Miss Charlotte E. Moore were added to the staff and have been engaged in solar investigations. Dr. A. A. Michelson and Dr. Henry Norris Russell, research associates, each spent a number of months in Pasadena and have carried on researches leading to results of great interest.

Among those who have visited the Observatory and taken part in the investigations in progress are Dr. E. Freundlich, of the Astrophysical Observatory at Potsdam and director of the Einstein Tower Observatory, Dr. John C. Duncan, director of the Whitin Observatory, and Dr. S. Rosseland and Dr. J. Schilt, research fellows of the International Education Board.

Construction Work. The principal new construction of the year has been the erection of the piers and house for the 50-foot interferometer. This has been nearly completed and the telescope which is being built in the instrument shop will be placed in position during the coming

spring. Much new apparatus for the Solar Laboratory has been designed and constructed, and among other instruments which have been completed are a new aluminum spectrograph for use with the 100-inch telescope, a stellar microphotometer, a quartz spectrograph for laboratory use, and a telescope for the registration of drift-curves in ultra-violet light. Three 40-inch concave mirrors have been figured in the optical shop, two of which are designed for Dr. Michelson's investigation of the velocity of light, and the third for the 50-foot interferometer.

Summary of the Year's Work.

The rapid increase in the solar activity as indicated by the number of sun-spots, prominences, and eruptions has added especial interest to many of the solar investigations of the year. The spectrohelioscope as designed and used by Hale has opened up new possibilities in the discovery and measurement of rapidly changing phenomena, and will prove of great value in guiding and interpreting observations made with the spectroheliograph.

The study of the polarities of sun-spots is particularly valuable because of the large number now visible, and the fact that they all belong to the new cycle. Observations by Nicholson, Ellerman, and L. H. Humason indicate that about 96 per cent of all those examined are of regular polarity, and hence show the reversal of sign as compared with those of the preceding maximum, which was discovered by Hale two years ago.

The important series of observations by Pettit on the ultra-violet radiation of the sun has been continued regularly throughout the year. The results show large fluctuations in the amount of ultra-violet light, with a marked direct correlation with sun-spot activity. A similar investigation of the ultra-violet radiation of the sun's center and limb is in progress.

A spectrograph designed by Anderson for observations of the flash spectrum was used by him at the Sumatra eclipse of January 14, 1926. Although clouds prevented satisfactory photographs, sufficient lines appeared on the negatives to prove that the optical method devised by him for greatly reducing the effect of bad seeing was fully successful and can be employed to excellent advantage in future observations.

St. John and Babcock have added greatly to their measures of solar spectrum lines, especially in the red and infra-red portions of the spectrum. Standards of wave-length based on selected lines of atmospheric oxygen have been determined by Babcock with the interferometer, and have been utilized by St. John in the measurement of solar lines on photographs taken with grating spectrographs.

The preliminary revision of Rowland's Table of Solar Spectrum Wave-lengths, which is being undertaken by St. John, should be of great value to those engaged in spectroscopic investigations. In addition to wave-lengths determined to a high degree of precision on the international system, the table will contain many new data on the

physical and astrophysical behavior of the lines, their identifications, series relationships, degree of ionization and energy-levels in the atom.

Numerous other solar investigations have been carried on during the year, including a study of the solar rotation by St. John, an examination of the wave-lengths of lines in the spectrum of integrated sunlight by Babcock, and several statistical researches on the relationship of sunspot areas, polarities and changes of size to strength of field and magnetic storms by Nicholson and Miss Losh.

Observations of the radiation of the planet Venus by Pettit and Nicholson with the thermocouple confirm their previous conclusions that there is little difference of temperature in the radiating surface before sunrise and after sunset on the planet. Their results are in agreement with the view that the radiating surface consists of clouds in the isothermal layer of the planet's atmosphere. Pettit has also measured the radiation from the moon and has derived a color-index of 0.92 from his results.

Babcock has confirmed his previous value for the wave-length of the green auroral line and is now engaged in studying its structure and intensity. Observations of the brightness of the night sky are being carried on as a part of a coöperative plan initiated by Lord Rayleigh.

The direct photography of nebulae has been continued by Hubble, Humason, and Dr. Duncan, partly for classification purposes, and partly for the detailed study of interesting objects. From a comparison of two photographs of the Net-Work Nebula in Cygnus taken 15 years apart, Hubble finds an expansion at the rate of about 10″ a century. Hubble has completed the determination of the distances of the irregular nebula N.G.C. 6822 and the spiral Messier 33 with results of 700,000 and 870,000 light-years, respectively. He also has made a statistical study of non-galactic nebulae, based on a classification according to forms of images. These nebulae present a smooth sequence of forms ranging from globular through elliptical to closely wound spirals, and finally to widely open spirals with arms resolved into stars. The surface brightness varies from type to type, but for each type is constant. The brightest stars in the spirals and the nuclei represent a constant fraction of the total luminosity. The data suggest an evolutional sequence of objects of the same general order of luminosity, uniformly distributed throughout space, and having an average mass about three hundred million times that of the sun.

In the field of stellar investigations van Maanen has completed trigonometric measures of parallax for a number of interesting stars, including Cepheid variables and stars of large proper motion, and has commenced photographic observations of double star positions with most promising results. Photometric investigations by Dr. Schilt have resulted in the discovery of several new variable stars, including two of the W-Ursae Majoris type. Thermopile measures have been used to determine the light-period of these stars.

A statistical examination of the distribution of different magnitudes with reference to the Milky Way has been made by Seares and Miss Joyner, based on the material of the Mount Wilson Catalogue of the Selected Areas and other available data. The results show systematic irregularities due to the displacement of the sun from the center of the galactic system, the northern hemisphere having less stars and the southern hemisphere more stars than the mean. The systems of stars defined by different limits of magnitude are not concentric, but with reference to the universe of stars of about the seventeenth magnitude the sun lies very nearly in the galactic plane and distant about 4000 light-years from its center.

Radial-velocity investigations of the year have included determinations for a large number of stars, among them numerous dwarf stars of high velocity, by Adams and Joy; the derivation of the orbits of four interesting spectroscopic binaries, including the ninth-magnitude companion of Castor which shows double bright lines, by Sanford and Joy; measures of stars in the Selected Areas by M. L. Humason and of red stars by Merrill; and an examination by Strömberg of the accuracy to be obtained in the measurement of radial velocities from objective-prism spectra taken with absorption screens which has yielded promising results.

Physical studies of stellar spectra have included investigations by Merrill of M, N, S, and Be-type stars; by Joy of the spectrum of o Ceti; and by Sanford of certain N-type stars. Merrill has made a discussion of the behavior of lines with reference to the atomic energy levels of their origin, and has examined the spectral changes of variable stars with variation in light. A number of spectra have been found, among them the well-known variable χ Cygni, in which zirconium and titanium-oxide bands are present simultaneously. Changes of a remarkable character have been observed in the spectrum of the Be star H.D. 161114, and fifteen new B-type stars with bright lines have been discovered by Merrill, M. L. Humason, and Miss Burwell. Sanford has detected two unidentified bands with heads at λ4868 and λ4979 in the spectra of sixteen N-type stars examined by him.

Through the aid of curves made with the microphotometer, Joy has found that the light-variation of o Ceti amounting to 5.5 magnitudes may be accounted for by the radiometric range in combination with the change in intensity of the titanium-oxide bands. Several new bands have been observed in the violet part of the spectrum. With an absolute magnitude of —0.3, derived by the spectroscopic method, and a measured angular diameter of 0".056, the linear diameter is found to be 490,000,000 km, and the surface brightness 7.5 magnitudes fainter than that of the sun. For an assumed mass five times that of the sun, the mean density is 1.1×10^{-7}, and the surface gravity 4×10^{-5} of the corresponding values for the sun.

New determinations of absolute magnitude and parallax have been

made for many stars by Adams, Joy, and M. L. Humason, and additional lines have been studied and included among those already used. Especial consideration has been given to stars of the M-type, and a list of over 400 stars, 100 of which are dwarfs, has been completed. The results show in a very marked way the division into giants and dwarfs: the average absolute magnitude of the giants is about —0.2, with 28 stars brighter than —1.0. These very bright stars show a marked galactic concentration. Among the dwarfs numerous stars are found to have large parallaxes, the values exceeding 0″.1 in nine cases for which no trigonometric measures are known.

Further stellar investigations have included measurements of stellar diameters by Pease, who has confirmed his previous values for Antares and β Pegasi, but finds a change in the diameter of Betelgeuse similar to that observed in 1922; radiometric observations of stellar energy by Pettit and Nicholson; further studies of the asymmetry in stellar motions by Strömberg, who finds the effect to exist even among stars of moderate velocity; and the classification of the spectra of faint stars in the Selected Areas by M. L. Humason.

The use of the high-current arc by King in the physical laboratory has provided most valuable data for the classification of spectral lines according to widening and change of wave-length in this source of high excitation. About 3000 lines in the spectra of chromium, cobalt, iron, manganese, and nickel have been classified in this way by Miss Moore. King has also commenced work with the high-current arc in a partial vacuum, and has obtained spectra which consist mainly of lines due to the ionized atom. In titanium, lines due to the second stage of ionization have been recognized by Russell.

Anderson and Smith have continued the investigation of the spectra of wire explosions and of the phenomena which occur at the time of explosion. A new 10 micro-farad condenser has been completed for use in this work, and new methods have been devised for securing photographs with exposure times of a few millionths of a second or less, and for studying the absorption coefficients in the metallic vapors by means of the rotating mirror spectrograph.

Measurements of standards of wave-length in the specified iron arc have been completed by Babcock for the region $\lambda 3400 - \lambda 6600$ and are being prepared for publication. The degree of accuracy attained is very satisfactory, the uncertainty for most lines averaging about 0.001 A. The differences between the new system and that adopted in 1922 have been calculated and are very slight except in the red portion of the spectrum.

The most complete analysis of a complex spectrum which has yet been made has been completed recently by Dr. Russell in the case of titanium. More than 1900 lines have been classified, 1400 of which belong to the arc spectrum, 500 to the ordinary spark spectrum, and 27 to that of the doubly ionized atom. A comparison of the systems of

terms found in the various spectra with those predicted by Hund's theory shows very striking agreement. From the limits toward which the 12 series discovered in the arc spectrum and two in the spark spectrum converge, Dr. Russell finds a principal ionization potential of 6.80 volts for the neutral atom, and 13.6 volts for the ionized atom. This is the first time that the ionization potential has been determined for a complex spark spectrum.

In connection with his measurement of ultra-violet solar radiation Pettit has made a laboratory investigation of the absorption properties of ozone and water-vapor. The constants of absorption of ozone in the region λ3100 - λ3300 have been measured, together with the bolometric intensities of the lines in the ozone bands as compared with the background.

Dr. Michelson has completed two series of measurements of the velocity of light on the 22-mile base-line between Mount Wilson and San Antonio Peak, each series consisting of 15 sets of observations. Two revolving mirrors have been used, one of 12 and the other of 16 sides, with speeds of 352 and 264 revolutions a second. The results found are remarkably accordant, the mean value, still to be regarded as provisional, being 299,800 ± 14 km/sec in vacuo. This important investigation will be continued on a base-line between Mount Wilson and Mount San Jacinto, giving a distance about four times as great as at present.

WALTER S. ADAMS, *Director.*

UNITED STATES NAVAL OBSERVATORY
WASHINGTON, D. C.

Changes in the staff in the year ending June 30, 1926: Department of Nautical Instruments and Time Service: COMMANDER A. G. STIRLING, U. S. N., vice LIEUTENANT COMMANDER J. F. CROWELL, U. S. N.; Supply Office: L. NEELY, vice F. J. HALLOCK; U. S. LYONS, Junior Scientist (Astronomer), appointed October, 1925.

(NOTE: Walter C. Myers, Junior Scientist (Astronomer) a member of the American Astronomical Society, resigned from the Naval Observatory, 7 September, 1926, and was appointed a Second Lieutenant, U. S. Army. He was drowned while swimming in the Potomac River 24 September, 1926.)

The activities of the Naval Observatory which are of no particular interest to astronomers will be omitted except to state that:

Stock of navigational and surveying instruments on hand is valued at $2,310,117.21.

The Nautical Instrument Repair Shop (15 men) repaired 5,171 instruments, at a cost of about $29,000.

The Naval Observatory furnished some of the instruments used by Lieutenant Commander Byrd, U.S.N., and Amundsen in their polar flights.

The radio time signals sent regularly at noon and 10 P.M., 75th Meridian Time, had two accidently poor signals, while the average error of all the others was 0.031 second with a maximum of 0.1 second.

Besides other sciences benefitting by these signals, oil companies use them in gravity determinations to locate oil deposits. The time signals from Bordeaux, France, were received on 240 days during the calendar year 1925, with a maximum difference (Washington—Paris) +0.19 sec., minimum +0.05 sec., average +0.10 sec. Special short-wave time signals sent via Arlington (Bellevue) in September, 1925, were easily recorded in New Zealand.

The plans for the round-the-world longitude determination, to begin October 1, 1926, were completed.

The superintendent as well as one of the staff attended the International Astronomical Union meeting at Cambridge, England, July, 1925, with gratifying results.

The Institute of Government Research published in April a monograph (113 pages) by G. A. Weber, giving an excellent but brief history of the Naval Observatory and its activities, organization, etc. Due to an inadvertent error, it failed to give credit to Carleton College as furnishing the time to certain railroads and places.

The Naval Observatory by radio, and via telephone and telegraph lines (mostly Western Union) furnished "time" to all the rest of the United States as well as to ships at sea.

The superintendent of the Naval Observatory was given the honorary degree of doctor of science by Wittenberg College in June, 1926.

Sumatra Eclipse

The total solar eclipse of January 14, 1926, was observed by the Naval Observatory party at Kepahiang, Sumatra. Of the total phase lasting $3^m\,08^s$ the first two minutes were cloudy. The last minute of totality was more or less clear, during which some good photographs were secured of the corona and prominences. Movie photographs of the partial phase, and of the corona at totality were made in a clear sky by the Navy operator from a location about 15 miles west of Kepahiang, on the road to Benkoelen. The spectroscopic observations at Kepahiang were practically failures on account of weather conditions.

Lieutenant H. C. Kellers (M.C.), U.S.N., besides being the medical officer with the expedition, secured over 9,000 specimens for the Smithsonian Institution.

Nautical Almanac Office

The *American Ephemeris and Nautical Almanac* for 1928 was received from the printer on April 5, 1926, and the American *Nautical Almanac* for 1928 on June 7, 1926.

All the copy of the *American Ephemeris and Nautical Almanac* for 1929 except 16 pages has been sent to the printer, and 402 pages are in type.

The investigation of the orbits of Saturn's satellites has been continued. One hundred and forty-nine sets of corrections to the elements have been obtained from 18 pairs of satellites, and equations of condition have been formed for 46 more sets, covering in all 22 oppositions.

The work on the determination of the orbit of Neptune's satellite based on 1639 observations made during 33 oppositions from 1889 to 1923 is in type and should be off the press in a few months. A full account of the results obtained is given in the *Monthly Notices of the Royal Astronomical Society,* for March, 1926.

DEPARTMENT OF ASTRONOMICAL OBSERVATIONS

6-inch Transit Circle and Prin Transit. With the Prin transit were observed 307 time stars and 45 azimuth stars.

With the 6-inch 3534 observations were secured, including the sun, moon, and planets, clock stars, time stars, and azimuth stars.

Volume XI, Second Series, *Publications of the United States Naval Observatory,* is in process of publication. It contains a discussion of about 50,000 observations of stars, and of the sun, Mercury, and Venus, made during the period 1909-1918, also a catalogue of fundamental stars, including those of Backlund and Hough, referred to the equinox of 1910.0.

Clock Vault and Clocks. The temperature of the clock vault was maintained practically constant during the year at 84° F. The three standard Riefler clocks performed satisfactorily. The total variation in daily rate during the year was:

No. 60. 0^{s}16; No. 70, 0^{s}22; No. 151, 0^{s}22.

9-inch Transit Circle. The observing program begun with this instrument in August, 1913, has been completed. The observing list included about 7561 intermediary stars (7.0 to 9.5 magnitudes), between +90° and —30° declination; 1414 standard stars (5.0 to 7.0 magnitudes), between +90° and —36° declination; and 1024 other stars in the fundamental catalogues and national ephemerides. In the first two classes the stars are uniformly spaced in the sky and together give five stars per hour per zone 2° wide. The list contains all stars in *Bulletin du Comité International Permanent pour l'exécution photographique de la Carte du Ciel,* Tome Septième, to —30° declination, and all stars in "Liste Générale provisoire d' Étoiles Fondamentales" (*Supplément à la Connaissance des Temps pour l' an 1914*), culminating at less than 75° zenith distance at Washington.

Four observations of each of the 10,000 stars have been secured.

The approximate number of observations of the various objects made in the 13 years is given below:

Intermediary stars	32,400
Standard stars	10,580
Clock stars	16,800
Azimuth stars	3,000
Zenith and refraction stars	1,000
Reflected and direct stars	2,330
Day stars	3,600
Sun	600
Moon	870
Planets	1,150
Total	72,330

Equatorials. With the 26-inch equatorial observations were made as follows: Comparison stars, 2; occultations, 18; Comet 1925 *c* (Orkisz), 1; Comet 1925 *d* (Tempel II), 2; Comet 1925 *f* (Borrelly), 5; Comet 1925 *j* (Van Biesbroeck), 9; Comet 1926 *b* (Blathwayt), 1; asteroid Nestor (659), 4; satellites of Saturn, 25; satellites of Uranus, 9; satellite of Neptune, 5.

With the 12-inch equatorial were observed 20 occultations, also 4 observations were secured of Comet 1925 *k* (Peltier-Wilk).

The preparation of the equatorial volume is well advanced.

Photographic Equatorial. This instrument has not been in operation during the present year. One of the pair of triple photographic lenses was dismounted for use in Sumatra at the total solar eclipse of January 14, 1926.

Observations of asteroids taken with this telescope have been measured and reduced to date.

Photoheliograph. Sun photographs were taken with this instrument on 218 days. There were spots on 216 days. It is probable that there will be a further increase in the number and size of solar spots and groups during the next two years.

Apparatus has been constructed for measuring the sun photographs, using transparencies which have been made from plotted charts.

Exchange of data with the Western Union Telegraph Company has been continued.

Photographic Zenith Tube. The number of observations secured during the year was 1907. The publication of the results for 1925 has been delayed by the absence of the astronomer in charge of this instrument on the Sumatra eclipse expedition, and because of the occurrence of some abnormal results in the latter part of the year, apparently due to trouble with the mercury reflecting surface.

Prime Vertical Transit. Observations have been continued of a list of zenith stars, to obtain accurate declinations, as well as proper motions in that coördinate.

The printing has been finished of Volume X, the prime vertical volume, and it is expected that it will soon be ready for distribution.

Library. The library contains 39,276 volumes and pamphlets, 276 having been added during the year.

EDWIN T. POLLOCK, Captain, U. S. N., *Superintendent.*

PRINCETON UNIVERSITY OBSERVATORY

PRINCETON, NEW JERSEY

Personnel. The Observatory Staff has been increased by the addition of Dr. Theodore Dunham, Jr., Thaw fellow, and Mr. Arthur S. Fairley, observatory assistant. Miss Moore resigned her position in December, 1925, having accepted a position at the Mount Wilson Observatory.

The preparation of the text book *Astronomy*, referred to in the last report, has occupied during the year a large portion of the time of all the staff. The manuscript went to the publishers in March, 1926, and proof-reading was well advanced by the end of the year. Volume I appeared in October, 1926. The expenditure of time involved in this has considerably diminished the amount of other work.

Theoretical Researches. Mr. Russell has continued to work mainly on spectroscopic matters. A discussion of the winged lines in the solar spectrum was published by Miss Moore and Mr. Russell; and a preliminary report upon a new theory of stellar evolution was presented at the Rochester meeting of the Astronomical Society. Mr. Russell published a note on ionization in giant and dwarf stars, in *Harvard Circular* 291.

Mr. Stewart published a note on the entropy of a star in *Nature*, also a brief paper in the *Physical Review* applying the Clausius virial to the calculation of radiation pressure in a gas. This also showed that gas pressure could be considered, statistically, as the result of repulsive central forces of a certain type between molecules at rest—a classical problem to which no solution had previously been given.

Mr. Dunham has investigated the arc spectra of manganese. Ten new multiple terms were found and series relations were assigned to 99 lines previously unclassified.

Observational Researches. Mr. Dugan, Mr. Dunham, and Mr. Fairley have made approximately 8400 photometric settings with the 23-inch telescope, on the following stars: RT Persei, X Triangulum, TY Pegasi, RX Hydrae, W Ursae Minoris, WW Aurigae, U Coronae Borealis, V Arietis, SX Geminorum, XX Cassiopeiae, RR Vulpeculae, RU Monocerotis, VW Pegasi.

Some 80 double exposure plates of eclipsing variable star fields and the North Polar Sequence, to be used in establishing accurate sequences for nine variables, were taken with the 5-inch camera by Mr. Dunham.

Observations of RT Sculptoris, X Triangulum, and WW Aurigae are now being discussed by Mr. Dugan.

A paper on photographic determinations of the position of the moon, by Miss Moore, was published in *Harvard Annals*, **85**, No. 9.

HENRY NORRIS RUSSELL, *Director.*

SMITHSONIAN ASTROPHYSICAL OBSERVATORY

WASHINGTON, D. C.

Personnel. The observatory operates two field stations: Mount Montezuma, near Calama, Chile—director, Hugh B. Freeman; assistant, E. E. Warner; Table Mountain, California—director, A. F. Moore; assistant, E. E. Smith. At Washington where computing, publication, and preparation of instruments are attended to: director, C. G. Abbot; aids, F. E. Fowle and L. B. Aldrich; computer, Mrs. A. M. Bond; instrument maker, A. Kramer.

Work of the Year. As for several years, there were maintained two

stations for the daily observation of solar variation.

The station formerly at Mount Harqua Hala, Arizona, was removed in October, 1925, to Table Mountain, California—Long. 117° 41′ W., Lat. 34° 22′ N., altitude, 7,500 feet. The removal was made possible by the generosity of Mr. John A. Roebling. It was done in order to avoid a period of hazy skies and numerous thunder storms which prevails in Arizona, particularly during the months of July and August. The new station has justified itself as far as weather conditions are concerned, for the number of days available for observation has exceeded the average at Harqua Hala, and the quality of the days is very decidedly improved.

For lack of funds the researches of Mr. H. H. Clayton on the relations of solar variation to weather conditions of North America, which had been supported from a private source through the Smithsonian Institution, were discontinued December 31, 1925.

A general revision has been in progress throughout the year of observations made at Mount Montezuma, Chile, since January, 1923, for the purpose of improving the accuracy of the results by statistical treatment to eliminate traces of atmospheric effect not removed by the primary computations.

Since January 1, 1926, the Weather Bureau has published the daily reports of solar-constant values as a feature of the daily weather map.

The National Geographic Society having made a grant to Mr. Abbot for the purpose of selecting the best site in the Eastern Hemisphere, equipping there a solar-radiation observatory, and maintaining it in operation for a period of several years, Mr. Abbot, after studies in Algeria, Egypt, and Baluchistan, selected Mount Brukkaros in South West Africa—Long. 17° 48′ E., Lat. 25° 52′ S., altitude 5,202 feet—for the purpose. The equipment was nearly prepared and the station in process of erection at the close of the period of this report.

Doubts continuing to be expressed in literature as to the reality of the variation of the sun, a new method of testing the matter was devised. It consists in selecting days on which the atmospheric conditions were substantially identical and comparing the apparent variation of the sun indicated by the pyrheliometry, or total solar radiation, with the variation of the sun indicated by ordinary solar-constant work as already published. A paper giving the theory and practice of this method, illustrated by observations of July 1910 to 1920, was published by Mr. Abbot in the *Monthly Weather Review* for May, 1926.

C. G. Abbot, *Director.*

SPROUL OBSERVATORY

Swarthmore College
Swarthmore, Pennsylvania

The 24-inch visual refractor was used on seventy-seven different nights. Only two months gave as many workable nights as the average

for the corresponding months over the past fifteen years. Three months, October, November, and February, established new low records. Two hundred fifty-nine parallax plates were secured by the various members of the staff. Thirty new parallaxes are ready for publication and eight other series ready for measurement. The plates were measured by Mr. Pitman and Mrs. Battin.

Mr. McLaughlin has continued his work in photographic photometry of variable stars. There are now 24 fields on the program for which there are over 200 photographs. A practically complete series, covering the whole period of W Ursae Minoris has been secured. A few more plates near secondary minimum are desired. A long series of UZ Draconis has been secured and shorter series for S Equulei and AD Herculis.

An expedition was sent out from the Observatory to observe the total solar eclipse on January 14, 1926, at Benkoelen, Sumatra. The members of the Observatory who were on the expedition were Mr. Miller, Mr. Marriott, and Mr. McLaughlin. The program was successfully carried out. We secured a large number of photographs of the corona with cameras of varying focal lengths. The largest camera used had an aperture of 9 inches and a focal length of 63 feet and the shortest camera used was of 30 inches focal length. Four spectroscopes were used by the expedition and one photographic photometer. Two cameras of 15 feet focal length and 6¾ inches aperture were used to photograph the field of stars surrounding the sun and also fields at some distance from the sun for the purpose of determining the deflection of the light rays by the sun. These plates have not yet been measured.

JOHN A. MILLER, *Director.*

VAN VLECK OBSERVATORY
WESLEYAN UNIVERSITY
MIDDLETOWN, CONNECTICUT

The 20-inch refractor was used on 143 nights in connection with the stellar parallax program and 584 plates were secured. Messrs. Slocum, Sitterly, and Stearns shared equally in the observing. A few of the first magnitude stars are being photographed with a differential occulting sector, but the observing list consists chiefly of faint stars with large proper motion.

Direct photographs of the sun were made on 108 days, 229 plates being secured.

Mr. Slocum has published a study of the 1925 corona.

Mr. Stearns has completed the measurement of the partial-phase photographs of the 1925 eclipse, and has derived therefrom a correction to the longitude of the moon.

Messrs. Slocum and Sitterly have as usual shared in the teaching, giving five courses.

FREDERICK SLOCUM, *Director.*

WASHBURN OBSERVATORY
UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN

There have been no changes in personnel during the year.

Considerable progress was made in the construction in the University Shops of a new mounting for Burnham's famous six-inch refractor. This mounting will be heavy enough to carry a ten-inch photographic lens, which has also been ordered.

The fifteen-inch refractor was used on 87 nights with the photoelectric photometer. The stars on the program include most of the spectroscopic binaries whose orbits have been determined. A new series of tests on red stars was begun, which shows that there are many variables of small range among these objects.

Progress was made in the printer's copy for a publication which will contain the photometric results of ten years at Urbana and Madison.

There was issued during the year Volume 14, Part 2 of the *Publications of the Washburn Observatory* containing meridian places of proper-motion stars by the late Albert S. Flint.

JOEL STEBBINS, *Director.*

YALE UNIVERSITY OBSERVATORY
NEW HAVEN, CONNECTICUT

Mr. C. L. Stearns resigned his place as research assistant at the end of June, 1925, to accept an assistant professorship at his Alma Mater, Wesleyan University. Owing chiefly to the absence of the director in South Africa this place remained vacant during the year. Mr. Walter O'Connell was appointed assistant at the Yale telescope in Johannesburg beginning November 1. Miss Mary Howe was temporarily engaged as a computer to assist Mr. Brown from March 10 to June 1. Miss Barney has been promoted to be chief of the computing department. Mr. Brown acted as director until September 1, when Mr. Schlesinger returned from South Africa and England.

The Reed telescope, an eight-inch refractor, was used for visitors and by the class in astronomy in Yale College.

The experimental work in observing variations in latitude with the zenith camera was terminated at the close of the preceding year and all the plates have now been measured. These results await final discussion. So far as they have gone they indicate a satisfactory degree of accuracy.

Very large plates covering about 150 square degrees, taken with the catalogue camera, were discussed by Mr. Schlesinger and Miss Barney in the fall. In order to derive from the measured positions accurate right ascensions and declinations it was found necessary to apply third-order terms. This was contrary to expectation, and no geometrical explanation for these terms is forthcoming. Accordingly, we overhauled

the instrumental conditions and found that the springs in the large plate-holder had exerted too much pressure on the glass plates and had made them slightly convex when they were exposed. The amount of curvature thus introduced was measured in the laboratory and was found to account for the character and size of the third-order terms. As a result, we can now say that these plates are capable of giving positions of the same order of accuracy as the small plates (covering twenty-five square degrees) upon which our two Gesellschaft zones are based.

Volume 4 of the *Transactions of the Observatory* was distributed in September, 1925; it contains the positions of 8359 stars, together with the proper motions of almost all of them, between declinations 50° and 55° north. In May, 1926, Volume 5 of the *Transactions* was distributed. This contains the positions of 5833 stars between declinations —2° and +1°, together with the data from which proper motions can be readily derived. Most of the work on this volume was carried out at the Allegheny Observatory. Through the courtesy of Mr. Curtis and of the Allegheny Observatory Committee, arrangements were made so that these results could be published in our *Transactions*.

Miss Barney is at present engaged in measuring similar plates in the zone 55° to 60°; by the end of the year about one-third of these measures and a corresponding amount of computations on them had been completed. It is expected that the whole zone will be measured by the spring of 1927. Dr. deSitter, director of the Leiden Observatory, has very kindly offered to have observed for us at his institution the positions of the comparison stars necessary for the reductions in this zone. This very welcome offer was accepted, and Dr. Hins, who is in charge of the Leiden meridian circle, began these observations in January, 1926.

Miss Pond has kept up to date the card catalogue of stellar parallaxes. She prepared for the printer the tabular matter for Volume 5 and for Part V of Volume 3.

Mr. Brown has been engaged in a discussion of the position of the moon as derived from meridian observations, photographic plates, occultations, and observations during the 1925 eclipse of the sun. He has been led to attribute those discrepancies in the moon's positions that are known as the fluctuations to changes that are going on in the interior of the earth, the effect of which is to cause small semi-periodic changes in the rate of rotation of the earth. If this hypothesis should prove to be correct it will remove the last discrepancy between his tables of the moon's position and actual observation.

In the fall of 1925, Mr. Reading constructed in our shops, in rather rough form, a measuring engine of a new type devised by Mr. Schlesinger. This engine was used by Miss Gesler to identify all the Gesellschaft stars on our plates of the zone 55° to 60°.

In the spring of 1926, Mr. Reading and Mr. States began the con-

struction of an engine suitable for measuring the plates taken with the telescope at Johannesburg. At the end of the year the actual construction of this engine was completed, but it remains to correct for straightness its two sets of guiding ways. When this is done the engine will be sent to Johannesburg to enable the observers there to measure a large portion of the plates that they secure.

Our 26-inch refracting telescope had been installed at Johannesburg shortly before the beginning of the period covered by this report. Mr. Schlesinger left Johannesburg on June 25, 1925, and on that date turned the telescope over to the charge of Mr. Alden who had arrived about a month earlier. Mr. Alden reports that exhaustive tests of the lens were made during July, August, and the first half of September. The parallax program was begun on September 19, but no plates were taken during the second half of the night until November 1, on which date the building containing living quarters for the staff, together with offices and a dark room, was ready for occupancy. Up to the end of the year there were obtained 2840 plates suitable for the determination of parallaxes and proper motions, preference having been given to those bright stars in the Southern Hemisphere whose proper motions in declination are accurately known. Mr. LeMay, professor of applied mathematics in the University of the Witwatersrand, secured a few of these plates as a volunteer observer. Mr. Alden has also secured fifty-four plates of the satellites of Saturn taken on forty-six nights; Mr. Cousins, a student of the University of the Witwatersrand, assisted in the taking of these plates as a volunteer observer. A comparison with the expert visual observations made simultaneously by Professor George Struve, working (as a visitor from the Babelsberg Observatory) with the 26-inch telescope of the Union Observatory at Johannesburg, shows the great superiority of photographic measurements for such work. At Professor Struve's request we have agreed to continue this work in future years so long as Saturn remains far south of the equator.

FRANK SCHLESINGER, *Director.*

YERKES OBSERVATORY

UNIVERSITY OF CHICAGO

WILLIAMS BAY, WISCONSIN

Personnel. The principal additions to the personnel were as follows:

Miss Alice H. Farnsworth, associate professor at Mount Holyoke College, was a member of the staff during the year, in charge of stellar photometry.

Miss A. V. Douglas, of the department of physics of McGill University, was volunteer research assistant until September 15, 1925.

Mr. F. E. Carr, of Oberlin, was volunteer research assistant during July and August, 1925.

Mr. C. T. Elvey was fellow during three quarters of this year, spending the autumn quarter at Ryerson Laboratory.

Mr. N. T. Bobrovnikoff also was a fellow during this period.

Mr. E. M. Justin had a scholarship, working the four quarters at the Observatory.

Mr. W. H. Garrett continued his work on planetary nebulae during the summer quarter of 1925.

Mr. Walter Baade of the Hamburg Observatory was at the Observatory as a guest of the University of Chicago from April 27 to June 23, 1926, continuing his studies of variable stars from plates which he brought with him.

Mr. Van Biesbroeck made a trip to the western observatories in March and April, 1926.

Mr. Struve left at the end of May for a similar trip and for work at the coast observatories.

Equipment. The large cast iron sheaves which carry the rising floor in the great dome continued to fail, cracking without warning, and they were accordingly replaced with steel sheaves from a similar pattern, supplied by Warner & Swasey. These changes were made by our own mechanical staff, without interruption of night hours, on July 27 to 30, 1925.

The equipment of the Bruce photographic telescope was increased by the addition of a 3-inch doublet lens, of focal length of 21 inches, which had been designed by Mr. F. E. Ross before he became a member of our staff, and was constructed by Mr. Robert Lundin at the Clark works in Cambridge. A new camera was made of duralumin for this lens by Mr. Ridell, and the instrument was in regular service after December 18, 1925.

A lens of focal length 5.63 inches, designed by Mr. G. W. Moffitt, and constructed by the McDowell Company, intended to enable the Bruce spectrograph to reach faint stars, was received May 3, 1926. A steel camera was adapted to the spectrograph for this lens, and preliminary work on its adjustment was begun.

A registering microphotometer with thermopiles by Coblentz and by the Epply Company was designed, chiefly by Mr. Elvey, and was constructed in our shop and put in service for the detailed study of lines in stellar spectra and for the measurement of the intensity of the continuous spectrum.

An optical bench was constructed by Mr. Ridell, according to the design of Mr. Ross, and was installed in the heliostat room on the upper floor of the Observatory.

A new enlarging camera for the photography of the planets and moon was made from plans by Mr. Ross and adapted to the 40-inch telescope.

A new sensitometer for testing plates and impressing standard squares was also constructed according to the plans of Mr. Ross.

The observing floor in the dome of the 24-inch reflector was considerably enlarged, increasing the convenience in operating that telescope. A finder with a diagonal eyepiece and illuminated cross wires was added to that instrument.

An interferometer for attachment at the eye-end of the 40-inch telescope was also made during this year.

An instrument which is very convenient for transforming spherical coördinates from one system to another was constructed for us and presented to us by Mr. H. H. Porter of Chicago. It consists of two concentric armillary spheres and can be read with an accuracy of about 0°.1. Galactic coördinates can be determined much more quickly than by the use of any tables yet published. We call the instrument the astrogon.

Weather Conditions. The atmospheric circumstances for observation were very unfavorable during this year, as is indicated by the table of the nocturnal hours of observation with the 40-inch telescope, and departures from the normal derived from the 20-year period, 1903-22. The normal was reached for only one month, December. These are not strictly comparable, since it is not our present practice to attempt photography or visual work with the great refractor, when the seeing is too poor, although the sky may be clear.

1925	Hours	Dep.	1926	Hours	Dep.
July	94	—57	January	90	—50
August	152	— 4	February	55	—74
September	104	—55	March	92	—42
October	90	—80	April	104	—16
November	115	—25	May	101	—19
December	132	0	June	97	—29
				1226	—451

During the year, for the day time, 63 days were perfectly clear, 144 days were clear for more than half the day, and 158 were prevailingly cloudy.

Solar Work. The spectroheliograph was used by Mr. Lee on 73 days and 179 successful exposures were obtained, chiefly on the prominences. On account of the Sumatra eclipse, a total of 22 exposures was made on January 13, 14, and 15. The data secured were published for the benefit of eclipse observers, in POPULAR ASTRONOMY for March, 1926. Seven copies of spectroheliograms on film, covering dates in the first half of 1925, were sent to the Kodaikanal Observatory at the request of its director.

Direct photographs, usually two in number, of the sun, were made with the 12-inch telescope on 159 days, chiefly by Mr. Justin. Extra photographs were frequently taken of the naked-eye spots, which were numerous after November, 1925.

Visual observations with the solar spectrograph attached to the 12-inch telescope were occasionally made.

Observations with the 40-inch Telescope. Micrometric. Mr. Van Biesbroeck made 349 measures of double stars on parts of 36 nights. Arrangements were made for the publication of his observations of double stars, begun in 1915. He obtained 90 positions of comets visually, 6 positions of asteroids, 5 positions of the satellite of Neptune, and 36 estimates of brightness of variable stars. He discovered Comet 1925 *j* in the finder of the 40-inch telescope on November 17, while setting for the Orkisz Comet, then faint, which happened to be in nearly the same position. He made a number of experiments with the type of interferometer described by Sr. Ronchi, of Florence, but these were not successful as applied with our telescope. Preliminary experiments were also made by Mr. Van Biesbroeck, with an interferometer of the Anderson pattern attached to the micrometer.

On parts of about 12 nights, Mr. Ross checked visually the brightness of some of the variable stars which he has discovered, by blinking the Barnard plates with his own, taken with the Bruce telescope.

Astrometric. One hundred and fifty-nine usable plates were obtained for the determination of stellar parallax on parts of 44 nights, by Mr. Lee. Parallaxes of 35 stars were determined by him and sent to the *Astronomical Journal* for publication. Twenty-three plates were taken by Mr. Van Biesbroeck on 8 nights, chiefly during the middle hours, for the determination of mass-ratio of binaries. Twelve plates were taken by Mr. Lee during the middle hours of the night for the determination of proper motions. A plate of N.G.C. 225 was obtained by Mr. Lee and measured in comparison with an earlier plate by Schlesinger for the determination of proper motions in the cluster, and the resulting paper was sent for publication in the *Monthly Notices of the Royal Astronomical Society*.

Part IV of Volume IV, of quarto publications of the Observatory, containing Mr. Lee's detailed discussion of the mass parallaxes and proper motions, of 1040 stars in 24 Kapteyn Areas at +45°, was put through the press during the year.

Spectrographic. On 106 nights which were clear, in whole or in part, 423 spectrograms were obtained as follows:

159 by Mr. Barrett
226 by Mr. Struve
31 by Mr. Elvey
7 by Miss Douglas

Forty-eight of these were taken with a dispersion of three prisms and 370 with a dispersion of one prism, for which the Ross lens was used, bringing our total number of these plates up to 8148. Five plates of stars were taken in experiments with the new Moffitt lens of short focus. Mr. Barrett made many experiments with the comparison spectrum in the sky for testing this lens, but they were not yet completed during the period under review. Most of the spectrograms were

taken in completing the work on B and A stars. Mr. Sullivan assisted as usual in guiding at the telescope.

During the year, Mr. Struve measured 602 spectrograms, chiefly of type A, among which he found several new spectroscopic binaries to be announced later. The orbits of two spectroscopic binaries, 37 ϕ' Orionis and τ^5 Eridani, were worked out by Mr. Struve and published in the *Astrophysical Journal*. The radial velocities of 368 helium stars were definitively reduced and the solar motion was determined from them. The results were presented in 1925, to the National Academy of Sciences, in a paper by Frost, Barrett, and Struve, and the extended paper was prepared for publication in the *Astrophysical Journal*. Madam Elisabeth Struve gave valuable assistance throughout the year in the computations involved in this work.

Systematic corrections are being applied to the measures of A stars and the reductions are up to date.

Mr. Struve also continued his special study of the calcium lines in the B stars and made a statistical examination of spectroscopic binaries, these papers appearing in *Popular Astronomy, Monthly Notices,* and *Astronomische Nachrichten*.

Miss A. V. Douglas worked during the summer of 1925 on criteria for determining the absolute magnitudes of the A stars, and made excellent progress. A large number of these spectrograms were loaned to her, upon her return to Montreal, and the results of her work developed into her doctor's thesis at McGill University. Her measures of the absolute magnitudes of 206 A stars were prepared for the *Astrophysical Journal*. While at the Observatory, Miss Douglas also experimented with the production of comparison lines in spectra obtained with the objective prism, using an absorbing filter of neodymium and other solutions.

In July, 1925, Mr. Struve made further experiments with the autocollimating spectrograph, attaining definition nearly equal to that of the Bruce spectrograph, but requiring much longer exposures. The instrument was not further used during the year.

Planetary Photography. With the new enlarging camera designed for the 40-inch, Mr. Ross made about 100 experimental photographs of Saturn, Jupiter, and Mars. A new feature is that the guiding is done on the object being photographed, by means of a thin plane-parallel glass plate in the cone of rays which reflects a small per cent of them into a guiding telescope.

24-inch Reflector. This instrument was used by Mr. Van Biesbroeck for obtaining photographic positions of comets as well as in continuation of the work on faint asteroids in collaboration with Mr. Struve. In these series 453 plates were exposed on parts of 85 nights. In this way 67 positions of comets were obtained and accurately measured by Mr. Van Biesbroeck; and longer exposures were made on several comets for recording their physical appearance, and the shape and ex-

tent of the tails. Sixty-six positions were obtained by the two observers for 36 asteroids, and plates exposed for 47 further asteroids failed to reveal them.

Plates for photometric and related purposes were taken by Miss Farnsworth as follows: 21 for proper motion of long-period variables; 17 for modified plan of exposure ratio; 15 on Kapteyn fields Nos. 40 and 41 for checking Vanderlinden's work in effective wave-lengths; 17 on list of standard stars for effective wave-lengths; 24 on Praesepe and Pole, calibration and scale plates for laboratory material, and 14 on Polar Sequence.

Forty-eight plates were obtained by Mr. Garrett for determining the color-indices of planetary nebulae, and 4 by Mr. Justin for the scale of magnitudes of stars near certain of Barnard's dark nebulae.

The 12-inch Telescope was used for daily photographic observations of the sun and for occasional visual observations of the prominences and the sun-spots and for the observations of comets and for general educational purposes.

Bruce Photographic Telescope. On 72 nights 117 fields were photographed in duplicate by Mr. Ross with this instrument. The new Ross doublet of wide angle was adjusted and permanently attached to the instrument. It appears to reach stars about ½ magnitude fainter than does the 6-inch Voigtländer, with the same length of exposure. In continuing the program of repeating plates taken by Mr. Barnard 15 or more years ago, which are compared under the blink machine, Mr. Ross found 393 more stars having proper motions larger than 0″.10, bringing the total number of these to 540. One of these had an annual motion of 3″.20 and a magnitude of 13, being evidently a small dwarf. Four lists of these stars have thus far been published in the *Astronomical Journal.*

One hundred and forty-seven variable stars were discovered during the year in the course of this work. One of them proved to be a nova which was bright on Mr. Barnard's plate in 1908 (see *Harvard Bulletin* 826).

From a comparison of two such plates obtained by him, during the summer of 1925, Mr. Carr found 16 stars having appreciable proper motions and averaging about 0″.50.

Zeiss U. V. Doublet. Mr. Bobrovnikoff obtained eight photographs of the spectrum of Peltier's comet and two of Van Biesbroeck's comet, on which the wave-lengths of the knots were measured. Twelve plates were obtained by Mr. Justin and three by Miss Farnsworth, for photometric purposes.

Plates were taken with the sky patrol, both with and without the objective prism, by Miss Douglas and others.

Experiments were made by Mr. Ross in the laboratory in photographing in different colors an electric bulb, with reference to its bearing upon the diameters of planets, photographed in different wave-lengths.

Progress was made during the year by Miss Calvert and the director in preparing for publication the Barnard Atlas of Selected Areas in the Milky Way, and composition was begun by the University of Chicago Press. Miss Calvert also worked on the preparation of the Barnard measures of the globular clusters and collected for the *Monthly Notices* his measures of the brightness of Nova Persei.

Mr. Elvey was occupied with the design and assembling of a registering microphotometer, which he utilized for the study of the spectra of novae from our extensive collection of spectrograms.

Mr. Bobrovnikoff continued his studies of the spectra and physical structure of comets, using the Barnard collection of negatives for the latter purpose.

Mr. Justin was engaged in the study of the absorption of certain dark nebulae, from photographs taken by Professor Barnard and supplemented by others taken by himself.

The Library. The efficiency of the library under the care of Mr. Barrett and Miss Van Biesbroeck was increased by a new arrangement with the University whereby we are permitted to order books directly and have them bound, without passing through the general library. There were added to the library 331 books, bound and unbound, and about 300 pamphlets.

The number of visitors at the Observatory during the year was 12,800.

EDWIN B. FROST, *Director.*

PLANET NOTES FOR MARCH.

By CLIFFORD E. SMITH.

The *Sun* at the beginning of the month will be part way across Aquarius. Its position March 1 will be R.A. $22^h\ 44^m$; Decl. $-8°\ 3'$. By the end of the month it will have partly crossed Pisces. On March 21, at 9 A.M., Central Standard Time, the sun will cross the equator, that is, it will be at the vernal equinox. Thus March 21 will be the first day of spring. The position of the sun at the end of the month will be R.A. $0^h\ 34^m$; Decl. $+3°\ 41'$.

The phases of the *Moon* for March will be:

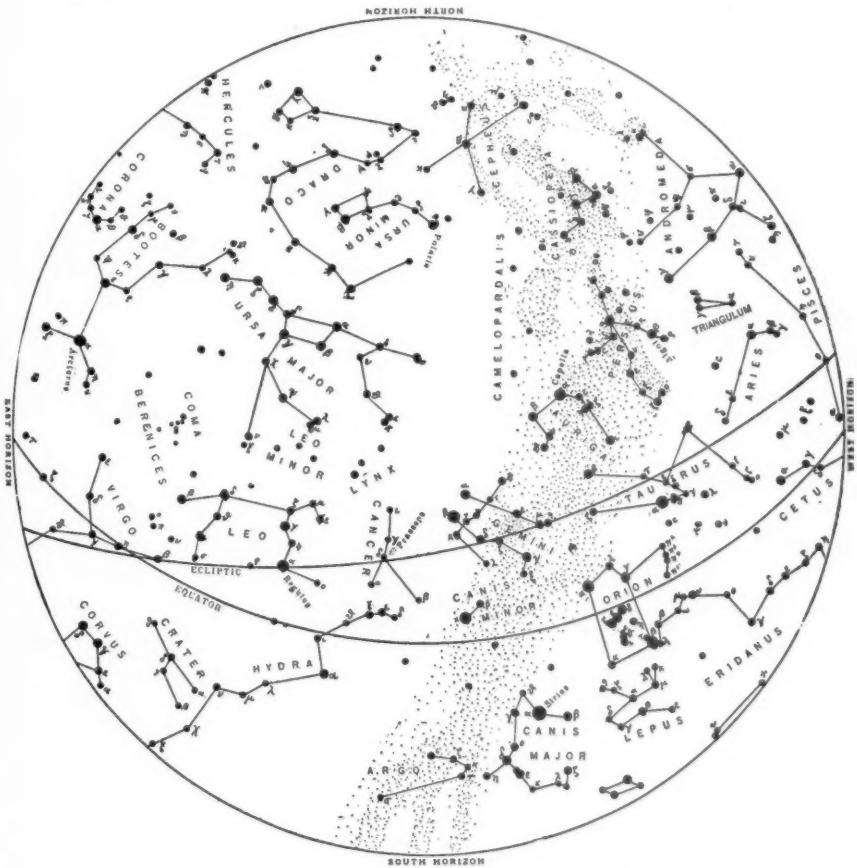
New Moon	March	3 at	1 P.M.	C.S.T.
First Quarter		10 "	5 A.M.	"
Full Moon		18 "	4 A.M.	"
Last Quarter		26 "	6 A.M.	"

The moon will be at perigee (nearest the earth) on March 4, and at apogee (farthest from the earth) March 18.

Mercury will be moving apparently westward in Pisces and will cross over into Aquarius about March 22. Mercury will set about one hour after the sun on March 1. It will be at inferior conjunction on March 13.

Venus, during the month, will move across the southern part of Pisces, and across part of Aries. At the end of the month it will set about two hours after the sun.

Mars will be moving across the central portion of Taurus. On April 1 it will be about four degrees south of the bright star β Tauri, and it will set about four and one-half hours after the sun.



THE CONSTELLATIONS AT 9:00 P. M. MARCH 1.

Jupiter will be in conjunction with the sun on March 1. During the rest of the month it will be west of the sun in Aquarius.

Saturn, during March, will be hardly a degree away from ψ Ophiuchi and about six degrees of arc north of Antares. For latitude 45 degrees north Saturn will rise about midnight at the middle of the month.

Uranus will be in Pisces. Conjunction with the sun will occur on March 21.

Neptune will continue to be in a position favorable for observation during March. It will be visible practically all night long just west of α Leonis.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1927	Star's Name	Magnitude	IMMERSION. Washington C.T.	IMMERSION. Angle from N	EMERSION. Washington C.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
Mar. 6	39 B. Arietis	6.5	20 19	38	21 8	280	0 49
8	162 B. Tauri	6.3	22 24	105	23 15	234	0 51
12	192 B.Geminorum	6.3	22 3	180	22 20	204	0 17
17	ν Virginis	4.2	19 44	133	20 55	278	1 11
21	22 B. Librae	6.4	23 33	176	0 16	246	0 43
23	ψ Ophiuchi	4.6	23 0	166	23 36	239	0 36

METEOR NOTES.

By CHARLES P. OLIVIER.

One of the aims of the writer in organizing the American Meteor Society was to have its headquarters available as a place to which records of meteoric phenomena might be sent that might otherwise be overlooked or lost. Partial success has attended this endeavor, and in its files are records of many interesting fireballs and peculiar meteors by persons who are not regular observers. For several years past most valuable assistance has been rendered by the Hydrographic Office of the United States Navy and the United States Weather Bureau, both of which kindly send in copies of all meteoric phenomena reported to them, principally by ships' officers.

To the date of writing (Jan. 8) twenty-four reports of single meteors or fireballs have been received from these two sources. In addition, it was reported from Havre, Montana, on 1926 Jan. 3, between 5 and 6 A.M., that many meteors lasting one or two seconds were seen in the northern sky—evidently Quadrantids. Also from *U.S.S. Dale*, off eastern Cuba, on 1926 Nov. 15, it was reported that many "shooting stars" were seen—evidently Leonids. In neither case, unfortunately, were actual counts made. The reports are valuable, however, as indicating considerable activity of these two showers on the dates mentioned.

From the reports of single objects we quote partially a few of the most interesting. From Captain A. P. Petterson of tug *Dispatch*: "At 11:15 P.M. Jan. 19, 1926, a meteor coming from eastward and dropping due S.E., seemed like a blazing ball of fire until nearing the horizon when it changed to a dull red. The meteor was followed by two shooting stars. . . It was later reported that . . . in latitude of Ensenada, Mexico, a violent shock was felt of such violence as to shake several residences. . . It (the meteor) dropped 4 miles S.W. of Ensenada." It would be well for an investigation to be made for a possible meteorite in this nighborhood.

From Observer Chas. Saderbaum of *S.S. Enterprise*: "May 15 at 7:15 P.M., ship's position lat. 22° 37′ N, long. 152° 53′ W, a meteor was observed to burst about 15° above horizon to the west, throwing out fire giving the appearance of small stars. The smoke from same remained in the same position 25 min. and

gradually took a zigzag appearance as per diagram (omitted). The rays of the sun that had just set made it appear as a streak of fire."

On 1926 July 20 at about 2:35 A.M., a splendid meteor appeared west of San Diego, Calif., and was reported by *S.S. Tiger* and *S.S. El Segundo*. Unfortunately neither ship gave complete data as to all the coördinates of the beginning and ending points so no path can be computed. This emphasizes the great importance of every observer carefully noting the coördinates of these points whenever a brilliant object is seen.

From *S.S. Hog Island*: "At 11:25 P.M., G.C.T., Oct. 20, 1926, in latitude 36° 30′ N, longitude 39° 35′ W, . . . It fell for about 15°, then hung suspended for about one second after which it seemed to explode and to form a large ball of fire, from which dropped a large fragment which fell, leaving a trail of sparks clear down to the horizon. This object when first observed was by Jupiter, which bore S 40° W true, altitude 26° 50′."

From *U.S.S. Dale*: "Nov. 15, 1926, at 0200, in lat. 19° 15′ N, long. 73° 30′ W, observed a meteor bearing 85° true about 10° above the horizon. . . A brilliant but not long trail was left in its path which expanded and remained discernible for about 10 minutes."

Only reports from these two official sources are mentioned in this month's note. However, the coöperation of all persons, interested in astronomy, is urgently requested in making the files of the American Meteor Society as complete as possible by sending in accurate accounts of any brilliant or peculiar meteors seen by them. These files should be most valuable for all future investigations on this subject.

COMET NOTES.

By G. VAN BIESBROECK.

The first new comet of this year was found in the southern hemisphere by Mr. T. B. Blathwayt at Braamfontein near Johannesburg. It will be remembered that the same observer has to his credit the discovery of comet 1926 *b*, which he picked up just a year ago, on Jan. 16, 1926. The telegram announcing the discovery was transmitted as follows through the Harvard College Observatory on January 15:

COMET BLATHWAYT. Johannesburg. Magnitude 9.
Jan. 13.0611 U.T. $\alpha = 15^h\ 44^m0$, $\delta = -29°\ 26'$
Daily Motion: $+12^s$ and $-50'$. Tail.

The comet was thus moving rapidly southward in the constellation of Scorpius and visible in the morning sky. It was, however, too near the horizon for northern observatories and no further measures were communicated. But it must have been well observed in South Africa, for on Jan. 19 the following parabolic elements computed by H. E. Wood of the Union Observatory, Johannesburg, were sent telegraphically:

Time of perihelion:	1927 Feb. 12.72 U.T.
Longitude of perihelion	$\omega = 228°\ 52'$
Ascending Node	$\Omega = 18\ 40$
Inclination	$i = 90\ 31$
Perihelion distance	$q = 1.060$

The orbit is almost exactly at right angles to the ecliptic. From its orientation it appears that the object will not become much brighter than at present and that it will stay out of reach of northern observers.

Further observations of the other comets visible at the present time were obtained here since last month. They are presented in order of increasing right ascension:

a) Periodic Comet 1926 *e* (Giacobini-Zinner) has now reached its most southerly declination of —16°, (see ephemeris in the January number, p. 47) but it is well situated in the evening sky and shows a short tail in a direction opposite to the sun.

b) Comet 1925 *b* (Reid) was last photographed here on 1926 Dec. 31. It is not likely that further observations will be secured here as the brightness is only 17M.

c) Comet 1926 *f* (Comas Solá) follows closely the ephemeris given in the January issue, the continuation of which I have computed:

Ephemeris of Comet 1926 *f* (Comas Solá).
(Elements Cunningham).

U.T. 1927	α h m s	δ ° ′	Log. Δ	Log. *r*	Mag.
Feb. 2.0	2 51 53	+20 43.7	0.164	0.261	11.9
6	57 57	21 37.6			
10	3 4 30	22 31.4	0.181	0.256	12.0
14	11 30	23 24.4			
18	18 57	24 16.7	0.197	0.253	12.0
22	26 51	25 8.0			
26	35 9	25 58.0	0.213	0.250	12.1
Mar. 2	43 52	26 46.1			
6	3 52 58	27 32.6	0.229	0.248	12.1
10	4 2 28	+28 17.3			

On 1926 Dec. 25, I made an exposure of 45 minutes on this object with the 24-inch reflector. This showed a broad tail about 3 minutes of arc in length, the axis of which was in position angle 85°. Visually in the 40-inch the tail is hardly visible over one minute of arc.

d) Comet 1925 *a* (Shajn) was again recorded as a round nebulosity of magnitude 15. In Tokyo Circ. 22, S. Kanda gives the following ephemeris:

U.T. 1927	α h m s	δ ° ′	Mag.
Feb. 5.0	5 13 39	—13 43.5	14.9
13	8 8	—12 59.5	
21	3 38	—12 13.9	15.1
Mar. 1	5 0 9	—11 27.9	
9	4 57 36	—10 43.1	15.3
17	55 54	— 9 59.8	
25	54 59	— 9 18.6	15.4
Apr. 2	54 44	— 8 40.5	
10	4 55 5	— 8 5.0	15.5

This requires a correction of about +10ˢ. Observers with large instruments will be able to follow this comet for some time yet. It is now already so far from the sun that it is outside the orbit of Jupiter.

e) Periodic Comet 1926 *g* (Neujmin) has passed its perihelion on January 16. When last observed here on January 14, the magnitude was estimated as 13. It has no sharp nucleus and a strong exposure with the 24-inch reflector does not reveal any trace of a tail, but only a faint round nebulosity some 100″ in diameter. The following ephemeris by the discoverer himself (Beob. Zirk. Nr. 44) is closer than the approximate one given last month:

U.T. 1927		α h m	δ ° ′	Mag.
Jan.	28.0	14 12.9	—19 46	13.0
Feb.	1	23.5	—21 35	
	5	33.9	—23 20	
	9	44.0	—25 1	
	13	53.7	—26 38	
	17	15 3.1	—28 12	
	21	12.1	—29 41	
	25	20.6	—31 7	
Mar.	1	15 28.6	—32 28	12.8

Exposures were made here on the regions where periodic comet Grigg-Skjellerup and periodic comet Pons-Winnecke are expected but neither object seems to be bright enough yet for being recorded with the 24-inch reflector. The conditions of visibility improve in both cases and the recovery of these objects may be expected soon. The following ephemerides are obtained from the data given in the *Handbook of the British Astronomical Association* for 1927. The value of the eccentricity e given there for comet Pons-Winnecke is that of $(1-e)$. I have computed this ephemeris backward somewhat further since the object may be found as early as February.

	Comet Grigg-Skjellerup		Comet Pons-Winnecke	
U.T. 1927	Perihelion May 10.0		Perihelion June 20.54517	
	h m	° ′	h m	° ′
Feb. 5.0	5 55.6	—12 46	13 38.6	+19 4
13	5 45.5	—12 13	13 50.0	20 37
21	5 38.5	—11 17	14 1.0	22 30
Mar. 1	5 35.0	—10 1	14 11.4	24 46
9	5 34.8	— 8 30	14 21.3	27 22
17	5 37.8	— 6 48	14 30.5	30 18
25	5 44.0	— 4 53	14 38.8	33 30
Apr. 2	5 53.1	— 2 45	14 46.2	36 51
10	6 4.8	— 0 22	14 52.6	40 14
18	6 18.9	+ 2 39	14 58.2	+43 29

In the case of comet Grigg-Skjellerup the uncertainty of the date of perihelion is thought to be about two days.

The orbit of Pons-Winnecke has been carefully investigated and the object will very likely be found close to the predicted position. In its return in 1921 it was first seen by E. E. Barnard as a 12^{M} nebulosity, at a time when the distances to the sun and the earth were similar to those on April 18 of this year.

Williams Bay, Wisconsin, January 21, 1927.

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1927 March							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			13 5					
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	8 1		15 17		23 8		31 1	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	7 4		14 15		22 3		29 14	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	1 2		13 7		25 12		31 15	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	4 17		13 7		21 20		30 10	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	1 10		8 7		22 1		28 21	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 16		14 3		21 7		28 11	
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	8 1		16 20		25 15			
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	7 12		15 11		23 9		31 8	
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	4 3							
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	8 13		17 3		25 18			
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	2 21		9 17		23 7		30 2	
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	6 10		14 8		22 5		30 3	
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	3 13		11 20		20 4		28 11	
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	5 5		13 3		21 1		28 22	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8			15 0		28 4			
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	2 17		9 2		21 15		27 22	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1			13 10				25 20	
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	6 8		13 0		19 16		26 8	
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	3 21		12 1		20 5		28 9	
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4 4		10 4		22 5		28 6	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	1 20		10 12		19 4		27 20	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	1 6		11 16		22 2			
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	4 10		12 11		20 11		28 11	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	5 10		11 3		22 15		28 8	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	1 22		13 3		18 7		29 22	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	2 8		10 13		18 18		26 23	
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	7 5		14 12		22 11		30 2	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	1 16		13 21		26 2			
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	2 21		10 1		24 9		31 13	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	6 0		12 19		19 15		26 10	
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	4 17		16 0		23 7			
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	1 2		7 17		20 22		27 13	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	7 20		16 6		24 15			
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	3 15		10 1		22 22		29 8	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	1 6		8 12		23 1		30 9	
X Carinæ	8 29.1	—58 53	7.9— 8.7	0 13.0	3 23		12 2		20 5		28 8	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6			9 17		19 4		28 16	
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	6 19		13 19		20 16		27 12	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	2 14		8 13		20 10		26 8	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7 16		14 11		21 4		27 22	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	9 12		16 22		24 8		31 18	
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	1 8		7 22		21 3		27 17	
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	3 22		12 17		21 12		30 8	
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	5 22		13 6		20 14		27 21	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	5 11		12 6		19 1		25 20	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	4 6		11 18		19 6		26 18	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	2 12		12 2		21 17		31 7	
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	5 0		12 10		19 21		27 7	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1927							
					March							
	h m	° ′		d h	d h		d h		d h		d h	
SX Hydræ	13 39.0	−26 23	8.6—12.7	2 21.5	6 10		15 2		23 19			
δ Libræ	14 55.6	− 8 07	4.8— 6.2	2 07.9	7 11		14 10		21 10		28 10	
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	4 1		10 23		17 21		24 18	
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.4	6 14		15 0		23 10		30 20	
SS Libræ	15 43.4	−15 14	9.3—11.5	0 18.4	6 19		13 23		21 4		28 9	
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	4 2		11 10		18 18		26 2	
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5			8 18		17 0		25 6	
R Aræ	31.1	−56 48	6.8— 7.9	4 10.2	6 21		15 17				24 14	
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1					21 7			
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	4 1		10 20		17 15		24 11	
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	1 16.2	7 23		16 8				24 17	
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	1 23		8 3		20 10		26 14	
TX Herculis	15.4	+42 00	8.3— 9.0	2 01.4	1 7		7 11		19 20		26 0	
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	1 19		9 4		23 22		31 7	
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	3 8		11 13		19 17		27 21	
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	1 5		8 18		23 20		31 9	
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	1 17		9 11		17 5		24 23	
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8			9 10		17 10		25 10	
WX Sagittarii	53.6	−17 24	9.2—10.8	2 03.1	7 2		15 15				24 3	
WY Sagittarii	17 54.9	−23 01	9.5—10.6	4 16.0	2 2		11 10		20 18		25 10	
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	3 22		14 6		19 10		29 19	
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	2 11		9 17		24 5		31 11	
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	2 22		9 20		23 16		30 13	
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2			11 5				26 9	
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	5 22		13 2		20 6		27 10	
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	5 0		12 3		19 5		26 8	
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	4 0		12 7		20 15		28 22	
RR Draconis	40.8	+62 34	9.3—13	2 19.9	2 22		11 10		19 22		28 10	
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	5 4		11 20		25 3		31 18	
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8			9 6				22 4	
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	4 1		11 17		19 8		26 23	
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	3 2		10 16		18 6		25 19	
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	4 5		11 10		18 15		25 20	
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	1 12		10 11		19 9		28 8	
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	3 11		10 5		23 18		30 12	
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 1		8 10		23 4		30 12	
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	5 19		11 1		21 13		26 10	
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 20		9 8		22 9		28 22	
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	4 16		10 16		22 17		28 17	
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	7 15		14 6		20 21		27 12	
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	3 19		12 22		22 2		31 5	
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3			8 1		16 11		24 22	
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	2 12		9 6		22 20		29 15	
UW Cygni	19.6	+42 55	10.5—13	3 10.8	2 15		9 12		23 8		30 5	
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0			12 10					
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	1 0		10 15		20 6		29 20	
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4			9 19		19 0		28 5	
Y Cygni	48.1	+34 17	7.1— 7.9	2 23.9	1 21		10 20		19 20		28 20	
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	7 2		14 18		22 5		29 23	
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 14		14 17				24 19	
RY Aquarii	21 14.8	−11 14	8.8—10.4	1 23.2	1 22		9 19		17 16		25 12	
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	7 23							
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	3 23		14 2		19 4		29 8	
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	2 0		12 8		17 12		27 22	
VW Pegasi	51.7	+32 42	10.0—10.6	5 06.4	3 13		14 2		19 8		29 21	
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	2 9		9 21		17 10		24 23	
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	1 17		9 23		18 5		26 11	

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1927							
					March							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7							30	13
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	6	18	14	22	23	1	31	5
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	1	6	9	0	16	17	24	11
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2			11	10			26	5
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	3	1	11	0	18	22	26	21
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	5	6	13	1	20	20	28	15
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	3	13			19	23		
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	1	18	10	8	18	22	27	12
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	2	11	13	13			24	17
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	3	1	14	16			26	7
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	6	10	14	2	21	18	29	10
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3			10	6	20	10	30	13
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	6	2	13	19	21	12	29	6
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	3	14	14	16	20	5	31	6
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	1	6	8	19	23	23	31	12
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3			9	11				
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	3	6	10	17	18	3	25	15
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	2	23	10	22	18	19	26	17
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	5	15	15	19			25	23
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	7	8					29	15
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4	7	12	6	20	5	28	4
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	2	17	9	10	22	19	29	12
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	1	21	11	4	20	11	29	17
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	4	2	12	20	21	13	30	7
Z Leonis	9 46.4	+27 22	7.9— 9.6	56 08.7								
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	2	14	9	9	22	22	29	17
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6	1	12	15	19	6	25	20
S Muscæ	12 07.4	—69 36	6.4— 7.3	9 15.8	7	10			17	2	26	17
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	5	18	13	18	21	17	29	17
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	5	8	12	2	18	20	25	13
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	1	19	7	15	25	2	30	2
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	6	13	15	22	20	15	30	0
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5			13	23	21	5		
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	7	22	16	3			24	8
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6	0	13	1	20	1	27	1
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	5	6	12	15	20	1	27	11
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	2	14	13	13	19	1	30	1
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5	20	13	10	20	23	28	12
R Trian.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	5	23	12	18	19	12	26	7
S Trian.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	4	20	11	4	23	20	30	4
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1			8	6	18	0	27	18
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	6	14	15	11			24	7
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	4	7	10	9	22	12	28	13
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	2	4	9	5	23	5	30	5
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	2	7			19	10		
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	2	15	10	6	17	20	25	10
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	3	23	9	18	21	7	27	1
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	4	21	11	15	25	3	31	21
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	7	4			17	12	27	20
RZ Lyræ	39.9	+32 42	9.9—11.2	0 12.3	6	12	14	4	21	20	29	12
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	8	14	16	0	23	11	30	21
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2			8	22	18	0	27	2
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	9	1	16	2	23	2	30	3
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	7	4	14	4	21	3	28	3

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of maxima in 1927							
					March							
	h m	° ′		d h	d	h	d	h	d	h	d	h
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	1	21	9	20	17	20	25	19
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	7	23	15	16	23	8	31	1
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	6	10	13	14	20	18	27	22
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	2	8	10	17	19	2	27	11
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	6	6	12	14	25	5	30	13
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3			14	11			30	20
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	3	16	12	13	21	10	30	6
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	2	21	10	4	17	11	24	18
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	8	2	15	6	22	10	29	14
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4			14	10			29	3
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	5	22	13	18	21	15	29	12
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	5	19	12	16	19	14	26	11
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	1	22	11	15	21	9	31	2
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	3	12	12	3	20	19	29	11
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	1	0	11	18	17	3	27	20
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	5	4	16	2			26	23
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	2	17	9	3	21	23	28	9
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	4	15	14	14			24	13
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	5	1	10	12	21	9	26	20
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	1	13	12	10	17	21	28	18
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6	1	12	8	24	22	31	[illegible]
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4			11	23			24	3
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	6	2	13	2	20	1	27	1

Monthly Report of the American Association of Variable Star Observers, for the month ending December 31, 1926.

The inclement weather of the past few weeks has had a telling effect on the size of the present report; the shortest submitted for many months. Nevertheless, the usual number of variables has been observed, although many less frequently. Reports have been received from thirty observers. We welcome lists from Miss Allen of Wellesley College, Mr. Bush of Mobile, Ala., and from Mr. Macaughey of New York City.

RY Sagittarii, *191033*, an irregular variable of the R Cor. Bor. type, has continued to decrease in magnitude, having reached the ninth at last reports. SU Tauri, 054319, another of the same type of variable, is fainter than normal maximum and requires close attention.

President Godfrey has appointed the following members as chairmen of their respective committees:

Committee on Slides, W. J. Fisher; Library Committee, P. R. Allen; Telescope Committee, Leon Campbell; Committee on Charts, D. B. Pickering; Committee on Occultations, J. E. G. Yalden; Committee on Publications, Miss Anne S. Young; Mechanical Construction Committee, J. E. G. Yalden; Pickering Memorial, W. T. Olcott.

The work of the Committee on Occultations is progressing favorably, and those members of the Association who are prepared to take a part, either in the computing or observing line, are urged to write to the chairman at once.

A recent paper by Dr. A. H. Joy of the Mount Wilson Observatory dealing with a study of o Ceti, Mira, from the spectroscopic point of view, refers to the high value of the work of the A.A.V.S.O., especially in correlating visual and spectroscopic observations of this oldest and best known of all variable stars.

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926.

Oct. 0 = J.D. 2424789; Nov. 0 = J.D. 2424820; Dec. 0 = J.D. 2424850.

J.D.Est.Obs.

V SCL
000339
815[13.3 Bl
S SCL
001032
791 8.3 En
795 7.7 Ht
797 7.6 En
805 7.3 Ht
813 7.4 Bl
814 6.7 Ht
816 6.7 Sm
851 6.2 Pt
X AND
001046
843 11.9 Wa
848 12.3 Lv
860 12.6 Lv
T AND
001726
814[11.8 Ch
860[13.2 Lv
T CAS
001755
814 11.8 Ch
825 11.6 Ch
826 11.8 L
845 11.0 Al
848 10.8 L
851 10.5 Pt
862 9.9 Ie
864 10.0 Bx
R AND
001838
814 10.8 Ch
825 11.0 Ch
851 11.8 Pt
852 11.8 Ie
857 11.7 Cd
S TUC
001862
802 10.0 Sm
815 10.1 Bl
816 10.0 Sm
S CET
001909
846 14.0 L
851[10.9 Lg
T PHE
002546
813 12.4 Bl
816 13.2 Sm
W SCL
002833
815 13.0 Bl
Y CEP
003179
843 10.2 Wa
852 10.7 Hu
856 11.2 B
856 11.3 Ie

J.D.Est.Obs.

U CAS
004047
848[13.0 Lv
860 13.2 Lv
RW AND
004132
814[11.0 Ch
X SCL
004435
815 14.0 Bl
RV CAS
004746a
851 13.9 Pt
— CAS
004746b
851 11.0 Pt
W CAS
004958
852 9.1 Hu
U TUC
005475
791 12.9 En
796 12.9 En
802 12.7 Sm
814 12.5 En
815 11.9 Bl
816 12.5 Sm
X CET
010102
851 9.1 Pt
U SCL
010630
813 11.5 Bl
S CAS
011272
823 11.5 Ch
851 9.0 Pt
852 9.4 Ie
U PSC
011712
851 11.5 Pt
RZ PER
012350
860 12.0 Lv
RU AND
013238
814[11.0 Ch
851 13.0 Pt
Y AND
013338
814 11.4 Ch
851 14.0 Pt
X CAS
014958
815 12.4 Bn
827 12.2 Bn
851 11.6 Pt
854 11.5 Bn
U PER
015254
851 9.5 Pt

J.D.Est.Obs.

R ARI
021024
814 10.4 Ch
822 10.2 Mj
823 10.4 Ch
825 10.0 Mj
828 10.0 Mj
832 9.6 Ch
848 8.7 Ms
851 8.2 Pt
860 8.5 Lv
862 8.1 Ae
864 8.2 Ie
W AND
021143a
851 12.2 Pt
852 12.3 Ie
T PER
021258
817 8.6 Ch
848 9.4 Ms
851 8.5 Pt
862 9.5 Ms
Z CEP
021281
851 11.6 Pt
856 11.0 Ie
o CET
021403
799 3.6 En
801 3.1 En
802 3.2 Sm
809 3.3 Ch
812 3.0 Go
814 3.0 Go
814 3.2 Ch
814 3.1 En
816 3.2 Sm
817 3.2 Ch
819 3.2 Sm
820 3.3 Ch
821 3.1 Go
821 3.7 Mj
822 3.2 Go
823 3.5 Ch
825 3.1 Go
825 3.6 Mj
826 3.2 Go
826 3.6 Ch
826 3.3 L
827 3.5 Mj
827 3.4 Go
828 3.5 Go
828 3.5 Mj
829 3.6 Mj
829 3.7 Ch
831 3.6 Mj
831 3.8 Go
832 3.8 Go
832 3.7 Mj
833 3.9 Ch
835 3.8 Mj

J.D.Est.Obs.

o CET
021403
835 3.9 Go
836 3.9 Go
840 4.0 Go
841 3.9 Mj
841 4.0 Wa
843 3.6 L
843 4.0 Jo
843 4.0 Wa
843 4.2 Ms
844 4.0 Mj
844 4.4 Ms
845 4.2 Ms
847 4.4 Ms
847 4.0 Wa
847 4.1 Mj
847 4.2 Mc
848 4.4 Ms
848 4.3 Mc
849 4.4 Mc
850 4.5 Mc
851 3.9 Bu
851 4.3 Pt
852 4.4 Wa
853 4.5 Mc
854 4.9 Ms
855 4.5 Mc
855 4.1 Bu
856 4.6 Wa
856 4.6 Mc
857 4.7 Mc
857 4.9 Ms
860 4.7 Wa
862 4.5 Jo
862 5.0 Ms
865 5.0 Ms
868 5.0 Bu
S PER
021558
817 8.4 Ch
848 8.4 Ms
851 8.4 Pt
862 8.6 Ms
R CET
022000
817[11.2 Ch
R FOR
022436
813 9.5 Bl
U CET
022813
817 7.7 Ch
821 8.5 Go
828 8.7 Go
829 8.8 Go
831 8.5 Go
832 8.5 Go
835 8.5 Go
836 8.5 Go
840 8.4 Go
851 9.2 Pt

J.D.Est.Obs.

RR CEP
022980
851 10.3 Pt
856 10.6 Ie
R TRI
023133
823 12.0 Ch
851 11.0 Pt
860 10.4 Lv
864 10.2 Ie
T ARI
024217
847 9.3 Ae
862 8.9 Ae
W PER
024356
822 9.1 Mj
825 9.2 Mj
828 9.2 Mj
848 9.2 Ms
851 9.1 Pt
856 9.5 Pj
862 9.2 Ms
864 9.0 Bx
R HOR
025050
791 10.6 En
795 10.6 Ht
796 10.6 En
802 9.8 Sm
805 9.5 Ht
813 7.7 Bl
814 8.5 En
814 8.0 Ht
816 7.3 Sm
819 7.3 Ht
T HOR
025751
802 8.6 Sm
813 9.7 Bl
816 9.3 Sm
X CET
031401
826 10.1 L
851 9.3 Pt
860 9.2 B
Y PER
032043
834 9.5 Go
851 9.1 Pt
R PER
032335
851 13.1 Pt
R TAU
042209
851 13.0 Pt
859 12.2 B
W TAU
042215
825 10.6 Mj
843 10.0 Jo
845 10.2 Al

J.D.Est.Obs.

W TAU
042215
851 10.0 Pt
862 9.5 Jo
S TAU
042309
859[13.5 B
T CAM
043065
826 10.9 L
847 11.8 Wa
851 12.2 Pt
X TAU
043208
859 9.4 B
R RET
043263
791 11.8 En
795 12.0 Ht
796 12.0 En
802 12.0 Sm
813 12.7 Bl
814 12.2 En
816 12.2 Sm
819 12.4 Ht
X CAM
043274
851 10.4 Pt
857 10.4 B
R DOR
043562
791 5.6 En
795 5.5 Ht
796 5.8 En
802 5.8 Sm
805 5.5 Ht
813 5.5 Bl
814 5.5 Ht
814 5.8 En
816 5.6 Sm
819 5.4 Ht
R CAE
043738
795[11.7 Ht
814 12.0 Ht
815 12.0 Bl
816[12.0 Sm
R PIC
044349
813 8.3 Bl
V TAU
044617
859 13.4 B
R ORI
045307
847 10.0 Wa
R LEP
045514
817 10.5 Ch
826 9.0 L
851 9.0 Pt
851 8.2 Bu

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926—Continued.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R LEP	T ORI	U ORI	X MON	T GEM	U HYA
045514	*053005a*	054920a	*065208*	074323	*103212*
862 8.4 Ae	844 10.1 Pt	856 9.0 Cb	821 7.4 Ch	835 8.8 Ch	826 4.8 L
V ORI	846 10.1 L	864 8.9 Al	826 7.4 L	851 8.7 Pt	R UMA
050003	851 10.1 Pt	864 8.7 Jo	851 7.5 Bu	U PUP	103769
851 13.5 Pt	856 10.7 Ie	V CAM	V CMI	*075612*	831 9.0 Ch
859 13.4 B	858 10.0 Pt	054974	070109	835 12.0 Ch	851 9.4 Pt
T LEP	859 10.8 B	860[13.3 B	827 9.6 Ch	858 10.2 Ae	862 11.3 Ae
050022	864 11.0 Pt	Z AUR	R GEM	864 9.8 Ae	W HYA
813 11.5 Bl	S CAM	055353	070122a	R CNC	*104620*
851 10.0 Pt	053068	820 9.4 Ch	821 8.4 Ch	081112	826 8.2 L
S PIC	851 10.5 Pt	841 9.8 Pt	844 7.2 Al	826 11.6 L	831 9.5 Ch
050848	RR TAU	844 10.2 Pt	851 7.1 Pt	833 11.3 Ch	851 8.5 Pt
814[12.2 En	053326	847 10.5 Pt	856 7.6 Cb	851 11.3 Pt	861 9.6 Ae
815[13.4 Bl	860 12.9 B	851 10.5 Pt	864 7.0 Al	V CNC	864 9.7 Ae
819[12.9 Sm	RU AUR	856 10.8 Pt	866 7.8 Ie	081617	W LEO
R AUR	053337	858 10.7 Pt	Z GEM	833 12.0 Ch	104814
050953	851 10.8 Pt	859 10.5 B	070122b	851 12.8 Pt	833[11.2 Ch
817 8.2 Ch	U AUR	864 10.7 Bx	851 12.4 Pt	RT HYA	S LEO
847 9.1 Wa	053531	864 10.7 Al	TW GEM	*082405*	110506
851 9.0 Pt	820 8.0 Ch	864 10.8 Pt	070122c	851 7.9 Pt	833 11.0 Ch
856 9.4 Cb	843 8.2 Wa	865 10.7 Pt	851 7.8 Pt	858 8.2 Ae	851 11.9 Pt
856 9.2 Wa	851 8.5 Pt	867 10.9 Pt	R CMI	864 8.1 Ae	SU VIR
860 9.1 B	859 9.1 B	868 10.7 Pt	070310	R CHA	120012
866 9.3 Ie	866 9.0 Ie	R OCT	826 7.7 L	*082476*	833[11.3 Ch
T PIC	SU TAU	*055686*	R VOL	818[12.4 Sm	R CRV
051247	054319	816[12.0 Sm	*070772*	S HYA	*121418*
795 9.8 Ht	817 9.9 Ch	X AUR	795[12.6 Ht	084803	864 14.0 Pt
805 8.6 Ht	821 9.8 Ch	060450	816[12.6 Sm	851 12.8 Pt	SS VIR
813 8.6 Bl	832 9.7 Ch	818[11.4 Ch	RR MON	T HYA	122001
814 8.4 Sm	844 9.7 Pt	835 11.0 Ch	071201	*085008*	826 7.0 L
814 8.6 Ht	846 10.6 L	851 10.6 Pt	821[11.0 Ch	851 10.7 Pt	T CVN
817 8.4 En	851 9.7 Pt	V MON	V GEM	T CNC	122532
819 8.2 Sm	852 10.3 Ie	061702	071713	085120	851 10.3 Pt
819 8.3 Ht	856 10.8 Pt	821 10.6 Ch	851 9.1 Pt	833 9.6 Ch	Y VIR
T COL	856 10.3 Ie	851 6.8 Pt	S CMI	851 8.5 Pt	*122803*
051533	858 10.7 Pt	852 7.2 Bu	072708	R CAR	826 9.6 L
795 7.5 Ht	860 9.9 B	R MON	821 10.0 Ch	*092962*	T UMA
805 7.7 Ht	864 10.0 Pt	063308	826 9.6 L	813 7.9 Bl	123160
813 8.0 Bl	S COL	851 10.6 Pt	829 9.7 Ch	X HYA	816 9.0 Kl
814 8.3 Ht	*054331*	NOV. PIC	847 8.8 Wa	*093014*	819 8.7 Kl
814 8.1 Sm	814[12.2 Ht	*063462*	851 8.8 Pt	831 8.0 Ch	831 7.7 Ch
819 8.1 Sm	819[12.6 Sm	795 6.2 Ht	864 8.1 Jo	851 8.0 Pt	850 6.8 Kl
S AUR	Z TAU	805 6.2 Ht	U CMI	R LMI	851 7.0 Pt
052034	054615a	814 6.2 Ht	073508	093934	853 6.8 Kl
820 9.2 Ch	852 13.8 Ie	819 6.2 Sm	826 12.7 L	831[11.6 Ch	855 7.0 Kl
847 9.0 Wa	RU TAU	S LYN	851 13.0 Pt	851 12.2 Pt	864 7.1 Jo
851 8.8 Pt	054615c	063558	S GEM	R LEO	R VIR
860 8.9 B	852 11.6 Ie	827 11.0 Ch	073723	094211	123307
856 9.2 Wa	R COL	851 13.4 Pt	820 8.5 Ch	831 7.2 Ch	826 6.2 L
858 9.2 Ae	*054629*	X GEM	827 8.3 Ch	847 6.1 Wa	851 7.3 Pt
W AUR	805[12.0 Ht	064030	832 8.7 Ch	851 6.0 Pt	RS UMA
052036	819[12.4 Sm	825 11.0 Bn	835 9.0 Ch	864 6.2 Jo	123459
820 9.1 Ch	U ORI	832 11.3 Bn	847 9.2 Wa	Y HYA	851 12.8 Pt
851 10.0 Pt	054920a	854 12.5 Bn	W PUP	*094622*	S UMA
859 10.6 B	817 6.6 Ch	W MON	*074241*	851 6.4 Pt	123961
S ORI	832 7.4 Ch	*064707*	813 10.5 Bl	V LEO	826 11.3 L
052404	843 8.4 Jo	851 9.5 Pt	816 10.4 Sm	095421	850 10.8 Kl
851 9.8 Pt	843 7.5 Wa	Y MON	T GEM	851 13.3 Pt	851 9.9 Pt
860 9.2 B	844 7.9 Al	065111	074323	S CAR	853 10.8 Kl
T ORI	847 7.7 Wa	851 12.9 Pt	820 9.0 Ch	*100661*	855 10.8 Kl
053005a	851 8.5 Pt		827 8.9 Ch	813 7.2 Bl	864 9.7 Jo
826 11.8 L	852 8.9 Hu		832 8.8 Ch		

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926—Continued.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RU VIR	Y LUP	X CRB	W HER	RU SCO	X DRA
124204	*145254*	154536	163137	*173543*	180666
851 12.8 Pt	815[12.4 Bl	864 9.1 Pt	816 10.8 Ch	812 8.9 Bl	844 11.5 Pt
U VIR	S APS	R SER	824 9.8 Ch	SV SCO	TV HER
124606	*145971*	154615	827 9.7 Ch	*174135*	181031
851 10.5 Pt	795 10.1 En	864 8.8 Pt	844 8.8 Pt	812 12.7 Bl	826 9.1 L
U OCT	799 9.9 En	V CRB	R DRA	W PAV	846 9.1 L
131283	802 10.4 Sm	154639	163266	*174162*	RY OPH
795[12.9 Ht	803 10.1 En	864 8.1 Pt	816 8.0 Ch	794 10.4 En	181103
813 13.4 Bl	806 9.9 Bl	RZ SCO	844 6.9 Pt	795 10.2 Ht	844 13.1 Pt
816[13.2 Sm	815 9.9 Bl	*155823*	864 6.8 Jo	799 10.1 En	W LYR
R HYA	816 10.1 Sm	791 11.6 En	RR OPH	802 9.7 Sm	181136
132422	819 10.1 Sm	795 12.0 Ht	*164319*	804 10.1 En	830 8.9 L
835 7.8 Ch	S CRB	797 11.6 En	791 10.2 En	805 10.2 Ht	844 9.0 Pt
864 8.3 Pt	151731	798 12.0 Ht	797 10.3 En	812 10.1 Bl	859 10.2 B
S VIR	824 8.0 Ch	802 11.2 Sm	802 10.4 Sm	814 9.6 En	RV SGR
132706	864 7.0 Pt	814[12.0 En	804 10.8 En	814 10.0 Ht	*182133*
864 12.2 Pt	RS LIB	Z SCO	S HER	819 9.9 Ht	812 9.7 Bl
RV CEN	*151822*	*160021*	164715	W ARA	SV HER
133155	790 10.6 Sm	794 10.2 En	844 12.1 Pt	*174551*	182224
806 7.8 Bl	794 10.9 En	795 10.1 Ht	RS SCO	794 8.6 En	844 10.4 Pt
R CVN	795 10.9 Ht	798 10.1 Ht	*164844*	799 10.0 En	846 9.8 L
134440	798 11.0 Ht	799 10.2 En	794 11.0 En	802 10.0 Sm	T SER
864 8.4 Pt	800 11.2 En	802 10.1 Sm	795 11.0 Ht	804 10.4 En	182306
T APS	X LIB	803 10.1 En	798 10.9 Ht	814 10.8 En	844 10.0 Pt
134677	*152849*	814 10.3 En	799 11.0 En	814 10.8 Sm	X OPH
813[12.7 Bl	791 9.2 En	R HER	802 10.6 Sm	819 10.8 Sm	183308
816[12.7 Sm	796 9.3 En	160118	804 10.6 En	RT OPH	844 6.6 Pt
RR VIR	799 9.4 En	816 10.5 Ch	805 10.9 Ht	175111	848 6.4 L
135908	802 9.1 Sm	SX HER	812 10.5 Bl	844 12.8 Pt	RV LYR
864 13.0 Pt	804 9.4 En	160325	814 10.4 Ht	RY HER	184134
R CEN	806 8.7 Bl	844 8.6 Pt	814 10.4 Sm	175519	844 10.0 Pt
140959	814 9.7 En	846 8.1 L	814 10.5 En	815 10.4 Ch	847 10.3 Wa
790 5.9 Sm	814 9.2 Sm	847 8.7 Pt	819 10.4 Ht	824 9.6 Ch	R SCT
794 6.0 En	815 9.0 Bl	864 8.0 Pt	819 10.2 Ht	835 9.6 Ch	*184205*
795 6.0 Ht	819 9.4 Sm	RU HER	RR SCO	844 9.4 Pt	814 5.7 Ch
796 5.8 En	S UMI	160625	*165030*	R PAV	817 5.6 Ch
798 5.7 Ht	153378	846 13.1 L	813 7.6 Bl	*180363*	826 5.6 L
799 6.0 En	864 8.5 Pt	R SCO	RV HER	794 8.7 En	833 5.6 Ch
801 5.8 En	T NOR	*161122a*	165631	795 9.1 Ht	841 5.5 Pt
802 5.9 Sm	*153654*	794 11.5 En	844 10.2 Pt	799 9.1 En	841 5.2 Cb
803 5.6 En	795 11.9 Ht	795 11.2 Ht	RT SCO	802 9.1 En	843 5.6 Ms
805 5.5 Ht	802 12.2 Sm	798 11.2 Ht	*165636*	805 9.8 Ht	843 5.6 Pt
806 5.8 Bl	814 12.8 Ht	799 11.7 En	815[13.0 Bl	814 10.3 Ht	844 5.4 Pt
814 5.9 En	R CRB	802 11.5 Sm	RT HER	814 9.8 En	844 5.2 Cb
814 5.5 Sm	154428	804 12.0 En	170627	816 9.8 Sm	846 5.2 L
815 5.5 Bl	810 6.1 Ch	814 12.0 En	844 9.5 Pt	819 10.8 Ht	847 5.4 Ms
U UMI	815 6.1 Ch	S SCO	RW SCO	T HER	847 5.3 Pt
141567	841 6.1 Pt	*161122b*	*170833*	180531	848 5.3 Ms
831 7.7 Ch	843 6.0 Ms	794[12.4 En	813 12.1 Bl	815 8.4 Ch	851 5.8 Lg
864 8.7 Pt	844 6.1 Pt	798[12.4 Ht	RS HER	826 7.6 L	851 5.3 Pt
S BOO	846 6.2 L	802[11.9 Sm	171723	835 7.1 Ch	852 5.7 Ie
141954	847 6.0 Ms	814[11.5 En	844 12.6 Pt	844 6.9 Pt	856 5.5 Pt
864 10.8 Pt	847 6.1 Pt	W OPH	S OCT	846 6.9 L	858 5.6 Pt
V BOO	848 6.0 Ms	*161607*	*172486*	860 7.7 Ie	864 6.1 Pt
142539a	851 6.1 Pt	815 11.0 Ch	795 12.8 Ht	863 7.9 Cd	865 6.2 Pt
826 9.2 L	857 6.1 Ms	U HER	814 13.0 Ht	864 7.7 Bx	866 6.1 Pt
864 10.5 Pt	864 6.1 Pt	162119	815 12.8 Bl	W DRA	868 6.2 Pt
R BOO	865 6.1 Ms	824 10.1 Ch	816[13.0 Sm	180565	RW LYR
143227	866 6.1 Ms	844 11.1 Pt	RU OPH	844 10.7 Pt	184243
833 7.8 Ch	867 5.9 Ms	SS HER	172809	856 11.6 B	846 13.5 B
864 7.7 Pt		162807	844 8.8 Pt		
		846 10.0 L			

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926—Continued.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Nov. AQL	RU LYR	R CYG	χ CYG	RW AQL	U CYG
184300	190941	193449	194632	200715b	201647
815 10.4 Ch	844 10.9 Pt	826 10.2 Go	864 7.8 Ae	862 9.1 Lg	845 8.0 B
841 10.6 Pt	W AQL	843 8.4 Jo	869 7.9 Cl	R TEL	862 8.4 Jo
844 10.8 Pt	*191007*	844 8.7 Pt	RR SGR	*200747*	U MIC
851 10.9 Pt	815 10.9 Ch	844 8.9 Cb	*194039*	815[13.5 Bl	*202240*
852 10.8 Ie	825 10.4 Ch	852 8.0 Ya	812 8.0 Bl	RU AQL	812 9.3 Bl
856 10.8 Pt	844 8.0 Pt	854 7.0 Hu	RU SGR	200812	RU CAP
858 10.6 Pt	T SGR	854 7.9 B	*195142*	864 9.4 B	*202622*
864 10.7 Pt	*191017*	862 7.2 Jo	791[12.5 En	W CAP	853[12.5 B
RX LYR	815 10.6 Ch	864 7.0 Ie	796 12.8 Ht	*200822*	Z DEL
185032	825 10.9 Ch	TT CYG	814 11.6 Ht	815[12.8 Bl	202817
815[11.9 Ch	844 11.0 Pt	193732	814 11.3 Sm	Z AQL	845[13.5 B
S CRA	R SGR	854 7.2 Hu	815 11.0 Bl	*200906*	856[12.9 Ie
185437a	*191019*	T PAV	819 11.0 Sm	844 9.0 Pt	SZ CYG
813 12.0 Bl	815 7.0 Ch	*193972*	819 10.9 Ht	RS CYG	202946
ST SGR	825 7.2 Ch	794 8.7 En	NOVA CYG	200938	841 8.8 Pt
185512a	835 7.2 Ch	795 8.6 Ht	195553	811 7.8 Ch	843 8.8 Pt
817[11.2 Ch	844 6.8 Pt	799 8.6 En	815[11.3 Ch	814 7.8 Ch	844 8.8 Pt
R CRA	RY SGR	802 8.6 Sm	841[12.2 Pt	815 7.8 Ch	847 7.1 Pt
185537a	*191033*	804 9.1 En	844[12.4 Pt	816 7.7 Ch	851 9.5 Pt
813 13.0 Bl	794 6.6 En	805 8.9 Ht	851[12.2 Pt	819 8.2 Ch	856 8.8 Pt
816[11.8 Ch	795 6.5 Ht	812 9.1 Bl	856[12.2 Pt	822 8.5 Ch	858 8.8 Pt
T CRA	798 6.5 Ht	814 9.6 En	858[12.2 Pt	823 8.0 Ch	864 9.8 Pt
185537b	799 6.8 En	814 9.5 Ht	864[12.2 Pt	825 8.2 Ch	865 9.6 Pt
813[13.0 Bl	805 6.7 Ht	816 9.2 Sm	Z CYG	826 7.8 L	866 9.6 Pt
Z LYR	812 6.5 Bl	819 9.5 Ht	195849	828 7.8 Ch	867 9.7 Pt
185634	814 6.8 Sm	RT CYG	816 9.6 Ch	831 7.8 Ch	868 9.6 Pt
844 13.1 B	814 6.3 Ht	194048	843 11.0 Jo	835 8.3 Ch	ST CYG
844 12.2 Pt	816 6.7 Sm	815 8.0 Ch	844 10.4 B	843 8.2 Jo	202954
854 13.5 B	817 7.0 En	819 8.0 Ch	844 10.8 Pt	844 7.6 Pt	844 11.0 Pt
V AQL	819 6.8 Sm	825 8.4 Ch	854 11.2 B	844 8.9 Cb	852 11.3 Ya
185905	819 6.3 Ht	833 8.6 Ch	864 11.8 Ie	848 8.0 L	852 11.4 B
817 6.5 Ch	824 6.5 Ch	843 8.7 Jo	S TEL	849 7.8 Gb	854[11.0 Pi
R AQL	841 7.9 Pt	844 9.0 Pt	*195855*	862 8.3 Jo	862 11.3 Ie
190108	844 8.1 Pt	852 9.5 Ya	815[12.6 Bl	R DEL	V VUL
815 6.5 Ch	TY SGR	854 9.0 Hu	SY AQL	201008	203226
835 7.2 Ch	*191124*	854 9.5 B	200212	844 13.5 Pt	844 8.8 Pt
844 7.0 Pt	812 11.0 Bl	862 10.0 Jo	831 13.2 L	846 12.9 L	R MIC
RX SGR	S SGR	864 11.3 Cd	844 12.6 Pt	RT CAP	*203429*
190818	*191319a*	TU CYG	846 13.1 L	*201121*	815[12.8 Bl
815 9.8 Ch	812 10.5 Bl	194348	862 11.8 Lg	844 6.6 Pt	Y DEL
825 10.0 Ch	SW SGR	815 10.1 Ch	864 11.4 B	SX CYG	203611
844 11.6 Pt	*191331*	819 10.2 Ch	S CYG	201130	843[12.0 Cl
RW SGR	813 12.9 Bl	825 10.8 Ch	200357	844 11.8 Pt	852 12.8 B
190819a	TZ CYG	833 11.5 Ch	816[11.4 Ch	852 10.6 B	S DEL
815 10.6 Ch	191350	844 11.5 Pt	863[13.0 B	RT SGR	203816
825 10.9 Ch	844 10.8 Pt	854 12.1 B	854[13.9 B	*201139*	844 9.6 Pt
844 11.5 Pt	U LYR	X AQL	R CAP	815 13.3 Bl	852 9.8 B
TY AQL	191637	194604	*200514*	WX CYG	854 10.0 Hu
190907	844 9.4 Pt	844 9.0 Pt	815 11.4 Ch	201437b	V CYG
844 10.7 Pt	TY CYG	859 8.8 B	853 10.4 B	815 10.6 Ch	203847
S LYR	192928	χ CYG	844 10.0 Pt	843 10.8 Jo	819[11.7 Ch
190925	816[11.2 Ch	194632	S AQL	844 10.2 Pt	847 12.5 Pt
816[11.6 Ch	844 12.6 Pt	830 11.4 L	200715a	852 10.4 B	852 13.4 B
852 13.7 B	RT AQL	844 9.1 Pt	818 9.5 Ch	862 10.0 Jo	854[10.9 Pi
X LYR	193311	847 9.7 Ae	844 10.5 Pt	864 10.6 Ie	Y AQG
190926	844 13.0 Pt	852 8.2 Ya	851 11.6 Lg	U CYG	*203005*
844 9.0 Pt	859 11.7 B	854 8.2 Hu	862 11.7 Lg	201647	815 11.5 Ch
RS LYR	R CYG	856 8.7 B	RW AQL	816 9.9 Ch	847 12.2 Pt
190933a	193449	858 8.8 Ae	200715b	831 9.7 Ch	T DEL
816[11.8 Ch	815 11.5 Ch	860 8.6 Ya	844 9.4 Pt	843 8.3 Jo	204016
844 11.9 Pt	825 11.0 Ch	862 7.9 Ae	851 8.8 Lg	844 8.1 Pt	852 13.7 B

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926—Continued.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V AQR	RS AQR	S CEP	T PEG	S AQR	ST AND
204102	*210504*	213678	220412	*225120*	233335
820 9.1 Ch	830 11.5 L	858 8.2 Ae	857[13.5 B	856 13.3 B	818 9.5 Ch
847 9.2 Pt	845 12.7 B	862 8.8 Ya	Y PEG	RW PEG	843 9.1 Wa
W AQR	847 12.5 Pt	RU CYG	220613	225914	845 9.0 Wa
204104	Z CAP	213753	851 11.8 Pt	841 10.4 Wa	847 9.2 Wa
846 13.9 L	*210516*	817 7.5 Ch	857 12.1 B	843 10.1 Wa	851 9.2 Lg
U CAP	847 13.5 Pt	847 8.2 Pt	RS PEG	847 10.1 Wa	851 9.3 Pt
204215	853 13.5 B	RV CYG	220714	851 10.1 Pt	852 9.1 Hu
815[13.1 Bl	R EQU	213937	851 12.8 Pt	852 12.0 Wa	854 9.2 Lg
853[13.9 B	210812	847 6.5 Pt	857 12.8 B	856 10.3 Wa	856 9.3 Wa
V DEL	864 13.5 B	852 7.5 Hu	T GRU	857 10.0 B	862 9.7 Cl
204318	T CEP	RR PEG	*221938*	860 10.2 Wa	862 9.4 Lg
852[13.7 B	210868	214024	790 10.9 Sm	861 10.5 Cl	R AQR
T AQR	811 7.2 Ch	851 13.6 Pt	816 10.1 Sm	864 10.3 Ie	*233815*
204405	823 8.0 Ch	857[13.5 B	S GRU	R PEG	817 9.3 Ch
815 7.8 Ch	826 7.4 L	R GRU	*221948*	230110	843 9.9 Wa
841 9.3 Cb	843 8.3 Jo	*214247*	790[12.8 Sm	843 12.2 Cl	847 9.7 Wa
847 9.5 Pt	847 8.5 Pt	790 11.6 Sm	791[12.8 En	851 12.4 Pt	851 8.8 Pt
856 10.4 B	856 9.3 B	791 11.6 En	817[12.8 En	852 12.4 Cd	854 8.9 Cd
RZ CYG	862 9.1 Ya	795 11.7 Ht	819[12.8 Ht	V CAS	856 9.1 B
204846	862 8.5 Jo	814 12.4 Sm	RV PEG	230759	Z CAS
847 11.2 Pt	RR AQR	814 12.4 Ht	222129	851 10.3 Pt	233956
853 10.6 B	*210903*	817 12.4 En	857 9.0 B	W PEG	863[13.4 B
S IND	847 12.5 Pt	819 12.4 Ht	S LAC	231425	RR CAS
204954	X PEG	V PEG	222439	816 8.6 Kl	235053
815[13.5 Bl	211614	215605	818 10.8 Ch	818 8.4 Cl	815 12.5 Bn
X DEL	847 12.6 Pt	843 8.8 Wa	843 9.7 Cl	827 8.7 Kl	827 11.8 Bn
205017	853 13.8 B	851 8.5 Pt	851 9.2 Pt	836 8.9 Kl	854 11.6 Bn
845 13.5 B	860[12.0 Ie	857 8.8 B	854 8.8 Pi	842 8.9 Kl	862 11.5 Ie
R VUL	T CAP	U AQR	855 9.0 Lv	850 9.5 Kl	V CET
205923a	*211615*	*215717*	856 9.3 Ie	853 9.5 Kl	*235209*
818 8.6 Ch	815[12.7 Bl	851 11.8 Pt	859 8.4 Lv	855 9.5 Kl	815 13.5 Bl
845 9.0 B	853[13.2 B	856 11.6 B	864 8.2 B	859 9.4 Lv	845[14.0 L
847 8.8 Pt	S MIC	RT PEG	R IND	S PEG	R TUC
854 9.0 Hu	212030	215934	*222867*	231508	*235265*
V CAP	812 8.7 Bl	842 11.1 Lv	815[13.5 Bl	818 8.2 Ch	791[12.9 En
210124	816 8.4 Sm	851 11.1 Pt	T TUC	851 8.5 Pt	816[13.0 Sm
815[12.7 Bl	Y CAP	857 13.1 B	*223462*	V PHE	R CAS
TW CYG	*212814*	860 13.4 Lv	791[12.8 En	*232746*	235350
210129	815[12.9 Bl	RV PEG	796 12.5 En	791 12.7 En	817 9.5 Ch
852 11.7 Ie	853[13.3 B	220133a	798 13.1 Ht	814 13.2 Ht	859 10.4 Lv
853 11.5 B	W CYG	851 12.5 Pt	814 11.4 En	817[12.7 En	V PEG
X CAP	213244	853 12.5 B	814 11.5 Ht	819 12.7 Ht	235525
210221	846 6.6 L	RZ PEG	816 11.4 Sm	Z AND	851 10.0 Pt
813 12.3 Bl	S CEP	220133b	819 11.3 Ht	232848	860 10.0 Ie
X CEP	213678	851 11.8 Pt	R LAC	818 8.7 Ch	SV AND
210382	839 8.2 Wa	853 11.7 B	223841	828 10.0 Mj	235939
856[13.7 B	847 8.2 Pt	T PEG	851 13.4 Pt	851 9.6 Pt	851 10.0 Pt
	853 8.7 B	220412	859 13.5 Lv		852 9.9 Hu
	854 7.9 Hu	818[11.6 Ch			862 10.1 Ie

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D. Est.Obs.	J.D. Est.Obs.	Star J.D. Est.Obs.	J.D. Est.Obs.
005840 RX ANDROMEDAE—		060547 SS AURIGAE—	
841.5[12.4 Pt	858.5[12.4 Pt	817.2 10.7 Ch	831.2[11.6 Ch
843.5[12.4 Pt	864.5[11.0 Pt	818.3 10.7 Ch	835.4[11.6 Ch
844.5[12.4 Pt	865.5[11.0 Pt	820.2 11.5 Ch	838.5[12.7 Cd
847.5 11.3 Pt	866.5[11.3 Pt	821.2[11.6 Ch	841.5[12.4 Pt
851.6 12.6 Pt	867.6[11.7 Pt	823.2 13.4 L	843.4[13.3 L
856.5[12.4 Pt	868.6[11.3 Pt	830.3[12.4 L	845.4[14.5 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1926—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
060547 SS AURIGAE—Continued						
	846.3	14.5	L	862.5	12.6	Ie
	847.5	12.6	Pt	864.5	12.7	Cd
	851.7	12.6	Pt	864.6	12.6	Ie
	852.5	13.3	Cd	865.5	11.0	Pt
	856.5	12.6	Pt	866.5	10.8	Pt
	856.6	13.8	B	866.5	10.8	Cd
	858.5	12.4	Pt	867.6	11.0	Pt
	860.6	13.3	Ie	868.5	10.5	Cd
	861.6	12.4	Cl			
074922 U GEMINORUM—						
	821.3	11.4	Ch	856.6	13.3	Ie
	827.2	11.6	Ch	858.7	13.7	Ae
	832.2	11.4	Ch	861.9	13.7	Ae
	851.5	13.3	Pt	864.9	13.7	Ae
	852.6	13.7	Ie			
213843 SS CYGNI—						
	816.1	11.8	Ch	826.2	11.5	Ch
	816.3	11.3	Kl	826.2	11.3	L
	817.2	11.8	Ch	827.2	11.6	Ch
	818.2	11.8	Ch	828.2	11.7	Ch
	819.3	11.3	Kl	829.2	11.7	Ch
	821.2	11.6	Ch	830.3	11.6	L
	822.2	11.6	Ch	831.2	11.7	Ch
	823.1	11.5	Ch	832.2	10.9	Ch
	823.2	12.0	L	833.1	8.7	Ch
	824.0	11.6	Ch	834.2	8.7	Ch
	825.2	11.5	Ch	835.2	8.7	Ch

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—Continued						
	836.2	8.3	Kl	852.5	11.3	Ie
	838.5	8.6	Cd	852.6	11.5	Hu
	839.6	8.5	Wa	852.6	11.5	Wa
	840.5	8.5	Wa	853.2	10.4	Kl
	841.5	8.7	Pt	853.6	11.6	B
	841.7	8.5	Wa	854.5	10.4	Pi
	842.2	8.3	Kl	855.2	10.9	Kl
	842.6	8.7	Lv	856.5	11.7	Ie
	842.6	8.6	Wa	856.5	11.5	Pt
	843.4	9.0	L	856.6	11.1	B
	843.5	8.6	Cl	856.6	11.9	Wa
	843.5	8.8	Pt	857.6	11.5	B
	843.6	8.9	Wa	858.5	11.6	Pt
	844.5	8.9	Pt	858.6	11.6	Ae
	845.4	8.9	L	860.5	11.7	Lv
	845.6	9.0	Ms	860.5	11.7	Ie
	845.9	9.2	Wa	861.6	11.7	Cl
	846.3	9.4	L	862.4	11.7	Ie
	846.6	9.7	Lv	862.5	11.5	Cl
	847.5	9.5	Ae	862.5	11.9	Ae
	847.6	9.7	Wa	863.5	11.5	B
	847.9	9.5	Pt	864.5	11.8	Ie
	848.5	9.8	L	864.6	11.8	Pt
	848.5	9.5	Ms	865.5	11.8	Pt
	848.6	10.3	Ly	866.5	11.8	Pt
	850.2	10.4	Kl	866.6	11.3	Ae
	851.5	11.6	Pt	867.5	11.8	Pt
	852.5	11.5	Ya	868.5	11.7	Pt
	852.5	11.5	Cd	869.5	11.5	Cl

Total observations, 1114; Total variables, 330; Total observers, 30.

The following observers have contributed to the results here presented: Miss Allen, "Ae"; Messrs. Allen, "Al"; Baldwin, "Bl"; Barnes, "Bx"; Bouton, "B"; Brown, "Bn"; Bush, "Bu"; Chandler, "Cd"; Chandra, "Ch"; Cherrington, "Cb"; Clement, "Cl"; Ensor, "En"; Gaebler, "Gb"; Gomi, "Go"; Houghton, "Ht"; Hunter, "Hu"; Iedema, "Ie"; Jones, "Jo"; Kohl, "Kl"; Lacchini, "L"; Leavenworth, "Lv"; Logan, "Lg"; Macaughey, "Mc"; Miyajima, "Mj"; Mrs. Morris, "Ms"; Messrs. Peltier, "Pt"; Pickering, "Pi"; Smith, "Sm"; Watson, "Wa"; and Yalden, "Ya".

LEON CAMPBELL, Recording Secretary.

January 6, 1927.

GENERAL NOTES.

Dr. A. A. Noyes, director of the Gates Chemical Laboratory of the California Institute of Technology, Pasadena, has been elected president of the American Association for the Advancement of Science for the current year. This association has a membership of more than 13,000 scientists scattered throughout the United States and Canada.

Professor G. D. Birkhoff, Harvard University, is the recipient of the annual prize of one thousand dollars offered by the American Association for the Advancement of Science. This prize was inaugurated at the seventy-fifth anniversary meeting, at Cincinnati in January, 1924, and "is awarded each year to the

author of a notable contribution to the advancement of science presented at the annual meeting of the Association." Professor Birkoff's paper was on the subject, "A Mathematical Critique of Some Physical Theories." It was read as the address of the retiring president of the American Mathematical Society.

Herbert C. Hoover, Secretary of Commerce, delivered an address at a general meeting of the American Association for the Advancement of Science on the evening of December 28 in the auditorium of Drexel Institute, Philadelphia. This session was held under the auspices of the Society of Sigma Xi. Mr. Hoover spoke on the subject, "The Nation and Science." He called attention to many convincing reasons for supporting adequately the work of research in science. This support, he said, should come from three sources, namely: (1) The State and Nation; (2) Industry; (3) Benevolence. The following quotations are suggestive of his thought: "I cannot bring myself to think that poverty clarifies thought or furnishes laboratory equipment." * * * "We cannot invent the scientist but we can give him an opportunity to serve." This meeting was presided over by Professor Forest Ray Moulton, of the University of Chicago, president of the National organization of Sigma Xi.

M. Jean Perrin, Professor of Physics at the Sorbonne, has been awarded the Nobel Prize in Physics for the year 1926. (*L'Astronomie*, December, 1926.)

Sir Isaac Newton Memorial.—The Yorkshire Branch of the British Mathematical Association will hold sessions at Grantham on March 18-20, 1927, in commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton. The program will include a paper by Sir J. J. Thomson on "Newton's Work in Physics," a paper by Sir F. Dyson on "Newton's Work in Astronomy," a paper by Dr. Horace Lamb on "Newton's Work in Mechanics," and a paper by Professor G. H. Hardy on "Newton's Work in Pure Mathematics." On Sunday morning a bicentenary service will be held, at which the sermon will be preached by Dr. E. W. Barney, The Lord Bishop of Birmingham.

Sigma Xi.—The annual convention of the Society of Sigma Xi was held at the University of Pennsylvania, in connection with the meetings of the American Association for the Advancement of Science, during the last week of December. At this convention two new chapters of the society were authorized, one at the University of Arizona and the other at the Michigan State College, East Lansing.

The announcement was made that a sum of one thousand dollars had been granted by the Society to Sir Ernest Rutherford, to be used by him in furthering the researches in progress in the Cavendish Laboratory.

A New Telescope for the University of Kansas.— The construction of a 24-inch reflecting telescope for the University of Kansas has recently been begun. Mr. William Pitt of Kansas City, Missouri, the inventor of the Irving-Pitt loose-leaf book, and an amateur astronomer for many years, who has made several excellent mirrors, will grind and figure the mirror and will build the driving clock. Mr. Pitt, who is an expert machinist, is donating his services for this purpose. Pyrex will be used in order to minimize temperature effects. It is estimated that the telescope will be ready for use in about two years. It is planned to use the instrument for determining positions of asteroids.

A Brilliant Meteor. — A meteor, bright enough to cast a strong shadow, passed approximately over Iowa City travelling in a direction east by southeast, at 6:02 P.M., Central Standard Time, on the evening of Sunday, January 2, 1927. The Des Moines and Fort Dodge papers, to the west, and the Burlington, Galesburg, and others east, carried items referring to it. In one way and another the University has received reports on this meteor from numerous points in eastern Iowa, several points in northern Missouri, and western Illinois and from two points in Wisconsin. It must have also been conspicuous in southern Minnesota, but no reports have been received from there. In spite of the numerous reports, few really useful observations have been received. As it occurred during the Christmas holidays a few astronomy students observed it while at home. A good observation was obtained by Huffer at the Washburn Observatory, Madison, Wisconsin.

CHARLES CLAYTON WYLIE.

University of Iowa Observatory, January 19, 1927.

New Comet. — The following telegram was received after this form was on the press: "Copenhagen cables Reid comet January 26.8219; R.A. $22^h\ 30^m\ 40^s$, Decl. $-57°\ 49'$; motion 44^s east, $4'$ south; magnitude 8.

BOOK REVIEW.

Astronomy, by John Charles Duncan (Harper and Brothers; price $3.75).

For some years there has been a distinct need for college texts in astronomy embodying the epoch-making results of modern research. Duncan's Astronomy is one of the recently issued texts supplying this need, and it will undoubtedly appeal to many teachers as the one best suited to the courses they are accustomed to teach. The author assumes about the mathematical maturity of students who have completed the ordinary freshman course in college mathematics, and consequently is able to include many simple derivations and demonstrations which add to the interest for properly prepared students, but are best omitted in the ordinary purely cultural course offered to students with no training in mathematics.

The book is well illustrated, the plates appealing to one as an integral part of the text, not merely as pictures added to give it an attractive appearance. Plate 7.1, colored, in the chapter on Spectroscopy, for example, should help greatly in explaining the continuous, bright line, and dark line types of spectra. There are also numerous figures and diagrams, on the whole rather carefully constructed. In his diagram of the orbits of the planets the eccentricity is shown, while in many texts the orbits are merely drawn as concentric circles. On the other hand, some of the plates might be better, and errors or omissions have gotten by in the case of two or three figures. Several misprints and minor errors were of course noticed as is to be expected in the first printing. It is to be hoped that the publishers will promptly correct the worst of these without waiting for a new edition.

The following rather disconnected comments may be of interest: (1) In the discussion of sidereal time and right ascension, he avoids the term "First of Aries," speaking simply of the vernal equinox. Other modern texts are dropping this term inherited from the astrological signs. The relations in solar time and

longitude are handled in the regular way, with the explanation that the definitions refer to "astronomic time, which is reckoned from noon." The astronomical day, now theoretically out of existence, is not mentioned. (2) In the discussion of the calendars the Eastern and Gregorian are compared, the error in the average length in the Eastern year being given as three seconds, and that of the Gregorian year as twenty-four seconds. It might be pointed out that the year is changing some five seconds per century, and that the comparison quoted was made on the assumption that the present length is constant. (3) In the latest editions of popular texts confused students can find for the length of the lunar day in terms of our day, 27⅓, 28.5, or 29½. This text merely states that day and night are two weeks in length, not giving the length more accurately. (4) The statements about moonlight being yellow are essentially correct. Observations have shown it to be yellower than sunlight. As compared with ordinary artificial light it is, however, surprisingly blue to one first making the comparison. The visual brightness of the full moon is about 0.27 candle-meters, in Hefner candles. Photoelectric measures indicate the photographic brightness is about 2.20 in the same units, or eight times as great. (5) In discussing the appearance of the sun and earth as seen from the different planets, the words "intensely bright star" appear twice on the same page separated by a few lines. They are first used to describe the appearance of the sun as seen from Neptune and then to describe the appearance of the earth as seen from Venus. This would lead students to think that the appearance of the sun as seen from Neptune is about the same as that of the earth as seen from Venus, which is far from true. As seen from Neptune, the sun would appear about a million times as bright as we see Venus at greatest brilliancy, while the earth as seen from Venus would at best appear about six times as bright. (6) In the chapter on the Law of Gravitation, we find the frequently quoted story that Newton first used an incorrect value of the earth's radius in testing the law of gravitation by the motion of the moon, and laid aside his work until with a new determination of the size of the earth the law was verified. Berry questions the accuracy of this story and Cajori says that it is merely a legend. As several reasonably good determinations of the size of the earth had been made before the time of Newton, he thinks that Newton would not have used the value of 60 miles to a degree, as the legend states. (7) In discussing the diameters of the stars it is correctly stated that Fizeau suggested the interferometer method of determining star diameters. It might also be mentioned that Stephan applied it shortly afterwards, and in 1874 announced that the diameters of the stars must be a small fraction of 0".16, the limit of his equipment. The eclipsing binary method of obtaining star diameters is worthy of mention, as this method has given us the diameters of many stars of various types, even though the parallax is not known. The interferometer method reaches only the giant red stars and the parallax must be known.

The chapter on Nebulae is interestingly written and well illustrated, most of the photographs having been taken by the author. Hubble's recent work on the distance of the nearest spirals by the Cepheid Variable Method is of course discussed. A short chapter on Theories of Cosmic Evolution follows this and concludes the book.

CHARLES CLAYTON WYLIE.

University of Iowa Observatory, January 19, 1927.